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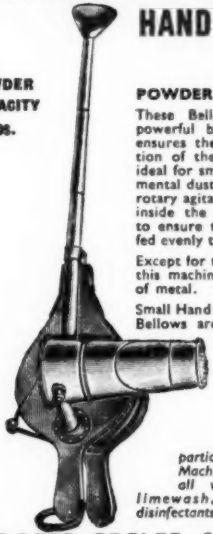

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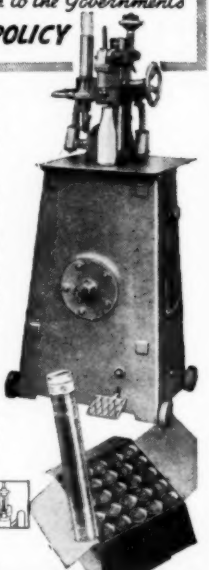

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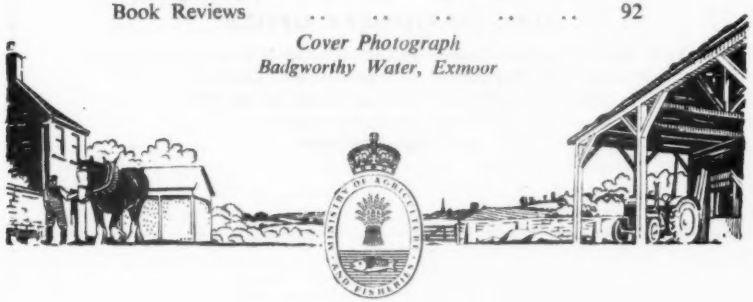

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 2 MAY 1949

WORLD POPULATION AND THE FOOD SUPPLY

JOHN GREEN

WILLIAM VOGT's *The Road to Survival*, recently published in the United States,* sets forth in cogent form a theme that has been dominating a section of American thought for some time. It is a matter that should—but for an amazing lack of geographical interest in this country—have dominated our own thought as a Commonwealth and colonial power. The Americans at least acknowledge what they owe the British—in particular to Malthus, Darwin and Mackinder. They were quick to read Jacks' and Whyte's timely book *The Rape of the Earth* and endorse the recent jeremiads of Sir John Boyd Orr. They have always been aware of soil and climate as the two geophysical factors that ultimately control human existence—perhaps because some of the world's great mountains, forests, rivers, deserts and prairies are within their own economic complex. What is more important—politically, they now hold a surplus of the world's food against the rising populations of Asia, South America and south-east Europe.

The Americans are beginning slowly to realize that the last frontier has been reached and that standards of living are affected by the number of people who must enjoy a given volume of resource. A nation may live in the midst of resources and yet be unorganized to use them, like Tsarist Russia; or it may be organized to enjoy the resources of other lands, like Britain in the nineteenth century, or even sea-locked Venice when she "held the gorgeous East in fee". It may so divide its realized wealth internally that the standard of living is high for one section of the community and low for another. But these political arrangements do not affect the fundamental proposition that the standard of living depends ultimately on the net produce of the lands and mines a people can command. Where there are few people to enjoy the fruits of a territory and they are technically well equipped to win them, the standard of living will be high, as in the white British Dominions; if too many people with a rising birth-rate occupy exhausted territory, the standard will be low, as in India and China. The classical economist assumed that the sources of power and raw material were unlimited, and that human industry was equal in every climate. These assumptions are still tacitly accepted in the Atlantic Charter.

American nutritionists believe that 2.5 acres per head of the population is required for an adequate standard of living. Over the whole continent of Europe, 0.88 of an acre is available. The United Kingdom, the Netherlands and Belgium (albeit colonial powers) have less than 0.3 of an acre. Moreover, it is of interest that those European countries with the highest birth-rates have the lowest standard of living—namely, Rumania, Poland, Italy, and Greece. Greece, with an average grain yield of only 13½ bushels

* Published in this country by Gollancz, price 15s.

an acre, accounts 12 acres a large farm. Italy, which in the mid-'twenties imported 80,000,000 bushels of wheat, had reduced this before the late war by 78 per cent. Despite this tremendous effort of self-sufficiency, Count Sforza said in 1946 that her sole problem was still over-population. In Asia the position is of course worse. From 1600 until 1867 the population of feudal Japan was stabilized at 26,000,000 : it is at present estimated to be 79,000,000. Americans have also computed that in China 100,000,000 people have starved to death in the last century.

In India, before the British came, the population was estimated at less than 100,000,000, and was held in check by famine, disease and war. In India today some 400,000,000 people now enjoy a diet of 1,400 calories against the 3,000 calories of 8,000,000 British stock who enjoy twice the area in Australia. In addition to having one-fifth of the world's people, the Indian further embarrasses the situation by keeping one-third of the world's cattle. Even the Soviet Union has a rising spiral of population commensurate with new stages in her industrial development.

In the nineteenth century the New World was able without war to absorb the expanding populations of Europe. Between 1850 and 1940 the population of the world doubled, but the population of the New World, the Americas and Oceania, quadrupled. It is not without reason that much of the best real estate in the New World today is in the hands of Highland emigrants, or that the Irish potato famine found ultimate relief in the gold rushes of the 'fifties. In more recent times Madrassi Indians cutting sugar-cane in Natal have opened the door to the Indianization of East Africa. The danger today is that already crowded countries will not offer asylum to economically displaced persons. The world is slowly recovering from a war of *lebensraum*. Germany wanted the *anschluss* and coveted the Ukraine in order to balance her economy and preserve a standard of living in Europe at the American level. The Japanese sought to lead the people of Asia towards the empty spaces of Australia. However, here is striking testimony that the story is not new :

> Let none of your possessions detain you, no solicitude for your family affairs, since this land which you inhabit, shut in on all sides by the sea, and surrounded by mountain peaks, is too narrow for your large population ; nor does it abound in wealth ; it furnishes scarcely enough food for its cultivators. Hence it is that you murder and devour one another, that you wage war, and that frequently you perish by mutual wounds. Let therefore hatred depart from among you, let your quarrels and your wars cease and let all dissensions and controversies slumber. Enter upon the road to the Holy Sepulchre ; wrest the land from the wicked race and subject it to yourselves.

Those words, as Mr. Vogt sardonically adds, were not spoken at Nuremberg : they were addressed to the Crusaders in 1095 by Pope Urban II.

Problem of Rainfall A factor that appears to obscure the European's perception of human affairs is indifference to rainfall. It has accounted for lamentable plantation failures (not only in the past but apparently at the present time) for extravagant hopes of population in countries like Australia, and for plain misplaced good intentions in colonial administration. We seem to forget that man is 60 per cent water and most of his food is water. This water is derived principally from the oceans by evaporation and precipitated onto the earth according to its topographical features. Mountain barriers and the depth of continents therefore affect climate : but it is also affected by soil temperatures and vegetation. While climatologists are not in agreement on the part transpiration from plants plays in maintaining the cycle of evaporation and precipitation—what they call grandiloquently the hydrologic cycle—

they are agreed that vegetation and forests affect soil temperatures and arrest the run-off of rains. The disappearance of forests in the Mediterranean area has coincided with the decline of several territories, formerly rich colonies of the Roman Empire. Nevertheless, wherever the European has appeared in the New World, his settlement has been preceded by fire and the axe ; so that the loss of timber is as much regrettable as its possible effect on the rainfall and climate.

The deterioration of grazing lands is considered to be as serious as the removal of timber. This insidious, economic loss is perhaps less spectacular than forest denudation. The western range lands of the United States comprise nearly 800,000,000 acres and support almost 75 per cent of the nation's sheep and over 50 per cent of its cattle. Formerly thronged with buffalo and the hunting-grounds of the Indian, their grazing capacity was raised by the white American to some 25,000,000 head. In 1935 it was estimated that over-grazing had reduced this capacity by half. Today some 35 per cent of the feed for western livestock comes from croplands or irrigated pastures ; while in Texas the use of commercial feed has increased by 400 per cent since 1906. It is suggested that these facts alone would account for the price of steak in the restaurants of Chicago and New York. In Australia there has been a corresponding decrease in the carrying capacity of the inland grazings. Although the sheep population has increased as the result of closer settlement and the reduced size of holdings, the true cost of producing merino wool must have increased considerably with the disappearance of saltbush, mulga and other edible shrubs. I need hardly stress that the carrying capacity of our own hill-lands has fallen progressively since the 'seventies through "extractive" farming practices. That was the conclusion in the Report of the Committee on Hill Sheep Farming in Scotland, published during the war.

Next in economic importance comes soil erosion. The world's topsoil is removed by either "gully," "sheet" or "gravity" erosion. Gullying occurs wherever man cultivates undulating and sub-humid soils which are subject to periods of intense rain. Incipient gully erosion can be arrested by contour ploughing, but this adds to the permanent cost of cultivation like drainage in the heavy soils of Britain. Gullying affects much of the world's wheat land. I have personally seen vicious examples in the fertile Palousse district of Washington State ; in New South Wales ; and in South Africa in the Western Cape. I have seen much worse in summer rainfall grazing areas where the value of the land did not justify conservation practices. There canyons twenty feet deep were scoured bare to the rock and the capacity of dams built to conserve water was entirely lost by siltation. By contrast, sheet or wind erosion may not be so spectacular, but it is the means by which dustbowls are formed. There is the reputed gesture by which Dr. Bennett wiped the soil of the Middle West off the window-sill in Washington and so persuaded Congress to inaugurate its Soil Conservation Service. The outstanding example in the British Commonwealth was the identification of Australian soil particles on the snow of New Zealand, 1,500 miles across the Tasman Sea. Gravity erosion occurs when steep slopes are uncovered and the soil seeks its natural angle of repose in hideous avalanches—this is often found in the tropics, and much grazing land in the North Island of New Zealand has been irreparably damaged in this way.

In Britain—apart from certain light fens—we do not experience soil erosion, because of the low rate of evaporation which results from our cloudy atmosphere. We do, however, suffer severe leaching of soil nutrients through rain. Before the war our use of nitrogen on farm land was some 68,000 tons, whereas last year it had increased to 185,000 tons. Month

by month we claim a new record of milk production, but this represents a daily drain from the soil of calcium and phosphate. An American has claimed that after forty-five years of cultivation the virgin soils of Ohio, Wisconsin and Illinois have lost 36 per cent of natural phosphate. New Zealand exports her staple products of lamb and butter to this country only by the most prodigal use of Pacific phosphates.

If, therefore, it is true that there is loss of carrying capacity in the earth's surface and at the same time an increase in population, can the situation be improved? So much emphasis is laid on birth control that one almost infers a body of Washington opinion in favour of it as a principle of United States policy. Mr. Vogt boldly poses the issue of: no aid without contraception. However, I do not believe that the quality of mercy could be strained to that extent by any wealthy people in an ignorant world—not, at least, until they have turned off their own taps, cut down their superfluous newspapers, and abated their immense enthusiasm for plumbing. But I do suggest that a profound moral consideration is posed by these American conservationists—if perhaps overlooked in their enthusiasm for more specious theories or facile solutions. Mr. Vogt really states his moral position when he writes:

> One of the strangest lacunae in human cultural development is the absence of understanding of man's relationship to his physical environment. So anthropocentric has he been that, since he began to achieve what we call civilization, he has assumed that he lives in a sort of vacuum.

Anthropocentricity Surely that word anthropccentric is the knot in the whole entanglement. Birth control may stop a human being existing, but it will not change the anthropocentricity of those who pass its barriers. False values must still be eradicated in the mind of civilization by self-examination and education. Teachers and moralists must believe that man has other duties than towards man and society in the abstract. I suggest that no amount of individual or social egocentricity or eccentricity can warp our attitude so much as this anthropocentricity. How else can we account for the present-day spectacle of our idealists standing in deserts of their own neglecting, while our materialists are daily hoist on the spoil heaps of their own meddling? Nor is indifference to environment an intelligent position in the post-Darwinian world. Religion and science that do not engender a respect for the physical environment surely deny the grandeur of human purpose. To foul one's nest is a term of maximum opprobrium, yet civilization today appears to lack any ethical standard that even makes such behaviour undesirable.

AGRICULTURE IN CANADA

2. EDUCATION, RESEARCH AND GOVERNMENT

J. A. YOUNG

Assistant Agricultural Adviser, Ottawa

THE first of these two articles appeared in last month's issue of *Agriculture* and gave a general description of farming conditions and systems of farming in Canada. A general idea of the organization of the Dominion and Provincial Departments of Agriculture is almost essential to an understanding of the organization of Canadian agricultural education and research.

The Agricultural Departments There is no hard and fast line between the fields of work of the Dominion and Provincial Departments of Agriculture, but generally speaking the Dominion Department concentrates on matters affecting the nation as a whole, e.g., research and experimental work, national production planning, and inter-provincial and overseas marketing, while each Provincial Department is concerned more with matters affecting its own province, such as executing production plans, and education and advisory work. In actual practice, however, the Dominion and the Provincial Departments work in co-operation on most forms of official agricultural work, sometimes one being the initiating or directing party and sometimes the other. Besides the Dominion Department of Agriculture, the universities and agricultural colleges (which are under provincial control) also conduct agricultural research, but the Provincial Departments of Agriculture scarcely enter this field.

The Dominion Department of Agriculture is organized into five main services:

PRODUCTION. This service administers the Government's agricultural production policy, including animal quarantine regulations, the eradication and control of livestock diseases, livestock and poultry improvement, crop improvement, controls relating to quality of seeds, fertilizers, feedingstuffs, etc.

MARKETING. All the Government's agricultural marketing legislation and policy is administered by this service, including economic research, dissemination of information on markets and prices to farmers and on food regulations and supplies to consumers, grading and inspection of livestock, vegetables and other products going across provincial boundaries or for export, etc.

EXPERIMENTAL FARMS. There are Experimental and Illustration Farms in every region conducting investigations to develop the best yielding and highest quality varieties of farm and horticultural crops, the most efficient methods of producing and harvesting crops, the improvement of the fertility of the soil, and the breeding and feeding of poultry and livestock.

SCIENCE. This service has laboratories in all the main regions of the country. It carries out research in all aspects of plant and animal diseases and insect pests, agricultural chemistry and bacteriology, and administers the various regulations for preventing the entry and spread of plant diseases and pests.

INFORMATION. Experimental and research findings of the Department are conveyed to farmers and housewives, and to extension workers serving these, through bulletins, exhibits, documentary films, etc. The service is responsible for general publicity and public relations, and includes the Departmental Reference Library for research workers in the Department and in agricultural colleges.

In addition to these services within the Dominion Department of Agriculture, there are two other agencies operating under the jurisdiction of the Dominion Minister of Agriculture. These are the Prairie Farm Rehabilitation Administration, whose chief aim is to overcome the effects of drought and soil drifting in the prairies by the expansion of irrigation and the construction of dug-outs and stock-watering dams, as well as the establishment of community pastures on sub-marginal land, and the Prairie Farm Assistance Administration, which makes payments to farmers in areas of the prairies where very low crop yields result from drought, insect damage, etc.

Alongside the above permanent structure of the Department of Agriculture are the Meat Board, Dairy Products Board, and Special Products

Board, which are responsible, respectively, for administering export contracts in and controlling the marketing of beef, bacon, dairy products, eggs, poultry, fruits, vegetables, and seeds. These Boards consist largely of senior officials of the Dominion Department of Agriculture; they were appointed by the Minister of Agriculture at the beginning of the war and are still functioning.

A Wheat Board under the Department of Trade and Commerce was in existence before the war and still administers export contracts and controls the marketing of wheat.

University and College Education There are eight Canadian universities which award a degree in agriculture (B.S.A.—Bachelor of Science in Agriculture). In each of the three prairie provinces and British Columbia the course for the degree is given in the Agricultural Faculty of the provincial university. In Ontario the degree course is given at the Ontario Agricultural College at Guelph, which is run by the Ontario Department of Agriculture and affiliated to the University of Toronto for degree purposes. In the province of Quebec there are three agricultural colleges: Macdonald College, which is English-speaking and affiliated to McGill University in Montreal; l'Institut Agricole d'Oka affiliated to the University of Montreal, and l'Ecole Supérieure at Ste. Anne de la Pocatière, affiliated to Laval University, Quebec City. The last two are French-speaking. The Nova Scotia Agricultural College caters for the needs of the three maritime provinces, and its students generally finish their degree courses at Macdonald College or the Ontario Agricultural College. There are two veterinary colleges, the Ontario Veterinary College at Guelph and l'Ecole de Médecin Vétérinaire at St. Hyacinthe in Quebec. In all cases the course for an agricultural or veterinary degree extends over four years.

With the exception of Quebec, there are very few agricultural schools in Canada corresponding to the farm institutes in the United Kingdom. However, most of the universities and colleges mentioned give a two-year course (in addition to their degree course) for men who wish to return to the farms. In Alberta similar two-year courses are given at the agricultural schools at Olds and Vermilion. Quebec has about twenty residential schools giving farmers' sons one-year courses.

Research Work Agricultural research is carried on by the aforementioned agricultural colleges and agricultural faculties of the universities, by the National Research Council (e.g., processing and utilization of agricultural waste products), by Provincial Research Foundations, and by commercial firms, but the greater proportion of agricultural research in Canada is carried out and paid for by the Dominion Department of Agriculture. The bulk of the Department's agricultural research work is carried out by the Experimental Farms Service and the Science Service, the main exception being economic research, which is the responsibility of the Economics Division of the Department's Marketing Service.

It is difficult to draw a line of demarcation between the Experimental Farms and Science Services. In general, however, the Experimental Farms Service does more field and applied work than laboratory work, while the reverse is true of the Science Service. The former is organized along commodity lines, and the latter along fundamental science lines. The Experimental Farms Service is divided into the ten divisions of Field Husbandry, Soils and Agricultural Engineering; Cereals; Forage Crops; Tobacco; Fibre; Horticulture; Animal Husbandry; Poultry; Bees; and Illustration Stations. The six main divisions of the Science Service are Entomology, Botany and Plant Pathology, Chemistry, Bacteriology and Dairy Research,

Animal Pathology, and Plant Protection (a control division with powers to prevent entry and spread of specific plant pests and diseases).

The Director of each service, together with the chiefs of the divisions mentioned and staff specialists in each division, are located in Ottawa. The Experimental Farms Service has twenty-four Branch Experimental Farms or Stations, two forest nurseries, thirteen sub-stations, eight branch laboratories, and over two hundred Illustration Stations scattered across the country, while the Science Service has about forty regional laboratories in different areas.

To attempt to cover the entire field of agricultural research in Canada would be out of the question, but it may be helpful to mention a few research problems and projects. Although the tendency is for the different specialists to work more and more in teams, for the purpose of these notes the work will be divided into five parts : soils and climate, crops, livestock, processing and marketing, and economics.

SOILS AND CLIMATE The Experimental Farms Service (Division of Field Husbandry, Soils and Agricultural Engineering), in co-operation with soil scientists of the agricultural colleges and universities (or, in some cases, Provincial Departments of Agriculture), is conducting a nation-wide soil survey and classification. So far approximately 214 million acres have been surveyed, largely through the reconnaissance type of survey. Of this area, 135 million acres are occupied and about 77 million acres cultivated or improved farm land.

Valuable work on the micro-biology of soils is being carried on by the bacteriological laboratory of the Science Service in Ottawa. Studies in soil nutrients are in progress at many centres, e.g., radio-active phosphorus is being used at the University of Saskatchewan ; the University of Alberta and the Dominion Experimental Farm at Lacombe, Alberta, have obtained marked results from sulphur applied to grey wooded (podsolic) soils in northern Alberta ; workers of the Science Service laboratories and Dominion Experimental Farm at Summerland, British Columbia, found that boron deficiency was the cause of serious trouble in the orchards of the Okanagan Valley of British Columbia ; various workers have shown that artificial fertilizers give little or no response on the prairies in dry years ; work has been done at Macdonald College, Ste. Anne de Bellevue, Quebec, on phosphate fixation.

At the Soil Research Laboratory of the Dominion Experimental Farm at Swift Current and at the Soil Mechanics Laboratory located at the University of Saskatchewan, the Prairie Farm Rehabilitation Administration is carrying out work on soil mechanics and soil moisture—crop growth relationships. The prevention of wind erosion of prairie soils has been and remains a major problem, and directly or indirectly engages the attention of many workers, including agricultural engineers, crop husbandry specialists, plant breeders, entomologists and plant pathologists. The most spectacular development in this field has been the replacement of the plough by the one-way disc and other implements that leave the old straw and trash anchored on the surface to protect the soil from blowing, i.e., "stubble mulch" farming. Work on farm mechanization occupies a prominent place at the Dominion Experimental Farms at Ottawa and Swift Current.

All the Experimental Farms across Canada are trying out different crop rotations ; existing practices are not so firmly established as in the United Kingdom. Coupled with this, water erosion of soils is receiving increasing attention and is the subject of work by the Central Experimental Farm at Ottawa. In general, rain falls more violently in Canada than in the United Kingdom, thus increasing the extent of soil erosion, particularly where row

crops, such as potatoes, maize, etc., are grown too frequently. Drainage is also gradually becoming more important in Eastern Canada and has been studied at Macdonald College, Quebec.

Irrigation research work is carried on at two main centres—the Experimental Stations at Lethbridge in Southern Alberta and Summerland in British Columbia. The former is the centre of the main prairie irrigated area (growing sugar beet, peas and other canning crops), while the latter serves the specialized apple (and other fruit) area of British Columbia. At Summerland and in many commercial British Columbian orchards the movable aluminium pipe sprinkler system of irrigation is in operation.

The Ontario Research Foundation, Toronto, is doing very valuable work on the classification of the climates of Canada based on the new Thornthwaite formula. Experiments to measure evapotranspiration (evaporation plus transpiration) in different areas are at present in progress.

CROPS AND GRASSLAND One of the most important aspects of agricultural research work in Canada has been plant breeding. At first the main search was for a spring wheat variety that would ripen early enough to avoid damage from the early autumn frosts of the prairies. Later, attention had to be turned to finding Rust-resistant cereal varieties, and the work of the Dominion Rust Research and Cereal Breeding Laboratory in Winnipeg in this field is world-famous. Later still (in 1947) a new wheat variety ("Rescue") with a solid stem and resistance to sawfly attack was introduced. The counteraction of the wheat stem sawfly is now a major problem in the prairies and is being tackled by a team of workers at the Dominion research laboratory in Lethbridge, Alberta. Rigorous tests for milling and baking quality are applied to all potential wheat varieties.

In Eastern Canada, resistance to lodging is very important in cereals, and a comprehensive study of this subject is at present being conducted by the Cereal Division of the Experimental Farms Service. The approach is to think of resistance to lodging in terms of the root system rather than the strength of straw. At the University of Manitoba the microbiology of grain in relation to heating is being investigated.

Forage crops are becoming increasingly important in Canadian farming. In the prairies one of the main essentials of a forage plant is resistance to drought. A big step forward was the introduction of crested wheat grass by the Dominion Forage Crop Laboratory in Saskatoon. Breeding and selection work with grasses and clovers is in progress at practically all agricultural research centres in Canada. Important research on Crown Rot and Wilt of alfalfa (lucerne) is going on at Lethbridge, Alberta. Outstanding work in the breeding of early maturing varieties of hybrid maize and soya beans has been done in the Forage Crops Division of the Central Experimental Farm at Ottawa, and, as a result, the area where these crops can be grown successfully has been greatly extended.

A co-operative potato breeding project between the Dominion Experimental Farm and the Entomology and Plant Pathology laboratories of the Science Service is in progress at Fredericton, New Brunswick. Here resistance to late Blight, Bacterial Ring Rot, Common Scab and virus diseases are top priorities in research. Control of aphides on potato crops is also being studied.

Apple and other fruit tree breeding work is carried out at the Central Experimental Farm at Ottawa and at the Experimental Farms at Summerland (British Columbia), Morden (Manitoba), and Kentville (Nova Scotia). At Summerland and Kentville, diseases and pests of fruit trees are studied in Science Service laboratories, the work at Kentville including a long-term study of the insect population of apple orchards. Work on virus diseases of

small fruits is done at Science Service laboratories at St. Catharine's in the Niagara Peninsula of Ontario, while fruit breeding work and a long-term study of the effects of cultural practice, spraying, etc., on the insect population of orchards are being conducted at the Provincial Experimental Station at Vineland, Ontario. The Science Service laboratory at Harrow, Ontario, carries out work on diseases of sugar beet and greenhouse crops.

Good work has been done on fruit tree spraying equipment at Summerland, British Columbia: as a result, a new sprayer which completely eliminates the handling of a hose has recently been put on the market.

Biological control work is performed at the Dominion Entomological Laboratory at Belleville, Ontario. The Dominion Laboratory of Plant Pathology in Saskatoon has done work on anti-biosis, e.g., a bacterium which is anti-biotic to root rot of cereals has been found. Work on the toxic principles of plant disease is going on at Macdonald College.

LIVESTOCK Various aspects of animal nutrition feature prominently in Canadian agricultural research. The large volume of work on pig nutrition done at Macdonald College has received wide recognition, while much good work on digestibility of livestock feeds and on the biological value of proteins has been done in Ottawa by the Chemistry Division of Science Service in co-operation with the Animal Husbandry Division of the Experimental Farms Service. A new animal nutrition laboratory has been set up at the Experimental Farm at Lethbridge to deal with special prairie nutrition problems. A biological laboratory for vitamin assays has been functioning in Ottawa since 1940, and the role of vitamins in poultry nutrition has been studied intensively at the Ontario Agricultural College and at the University of British Columbia in Vancouver.

Work on animal diseases and pests is going on at a number of centres, e.g., the animal pathology division of Science Service has done work on mastitis, contagious abortion, swine fever, coccidiosis of poultry, etc. The Ontario Veterinary College at Guelph, the Dominion Research Laboratory at Lethbridge and the Dominion Experimental Farm at Lacombe have worked on rhynitis, a relatively new disease of pigs. The biology of warble flies has been comprehensively studied at the Dominion entomological laboratory at Kamloops, British Columbia. The prairie regional entomological laboratory at Lethbridge has done similar work on the biology of horse bots and on the control of warble flies and other insect pests of livestock. The control of warble flies by high pressure spraying is now a common practice on prairie farms and ranches.

The development of a new breed of sheep—the Romnelet—is in progress by the Experimental Farms Service in the prairies. It is a result of crossing Romney Marsh rams and Rambouillet ewes. The aim is to find a sheep with the ranging ability of the Rambouillet but with better quality meat and wool. In north central Alberta the Experimental Farms Service has made headway in the development of a new type of animal (the Cattalo) by crossing domestic cattle with the buffalo. The aim here is to combine the hardiness of the buffalo with the meat quality of domestic cattle and produce a good animal for the more northerly areas.

Several new breeds of poultry have been produced at the Central Experimental Farm in Ottawa and at the University of British Columbia. Doubts have been cast on the ability of the progeny test to raise the standard of existing poultry breeds. In the case of pigs all efforts are concentrated on the Yorkshire (Large White) breed. The Experimental Farms Service has an extensive pig breeding programme aimed at securing further improvement in bacon quality through progeny testing, inbreeding and line breeding.

PROCESSING AND MARKETING Because Canada is an exporter of agricultural produce, a good deal of work has been done on the processing and packing of agricultural products, e.g., the National Research Council has worked on the production of butylene glycol from wheat (for synthetic rubber production) and on the malting quality of barley. The industrial utilization of wheat straw is being investigated at the Council's prairie regional laboratory in Saskatoon. This laboratory was set up primarily to investigate the utilization of waste agricultural products, mainly through fermentation processes.

The Council has also done work on the curing and smoking of bacon, meat storage and transportation (including dehydration and canning), manufacture of dairy products, dried egg production and preservation of shell eggs. The Horticultural Division of the Experimental Farms' Service both in Ottawa and Summerland (British Columbia) has done work on the storage and processing of fruits, including juice production, dehydration and quick-freeze methods. The Science Service has worked on the bacterial aspects of processed foods and on problems such as rancidity in Cheddar cheese, etc.

ECONOMICS The Economics Division of the Dominion Department of Agriculture conducts research in all provinces, mostly in co-operation with the agricultural economists of the universities but also with Provincial Departments of Agriculture and other bodies. This covers a wide field, including farm and ranch management surveys, land settlement, land use and classification, farm finance, marketing, agricultural co-operation, consumer demand and rural welfare. The Division is also concerned with domestic and foreign agricultural policy. It publishes numerous reports resulting from these research studies and, in addition, contributes three regular periodicals dealing with economic aspects of Canadian agriculture and activities in other countries that might be of interest to Canadian farmers and agricultural officials.

Farm Advisory Work Farm advisory work, or extension work as it is called in Canada, is the responsibility of the provinces. Each Provincial Department of Agriculture, therefore, has its own Advisory or Extension Service. The Dominion Department of Agriculture does not have an Extension Service but it gives much help to the provincial advisory staffs through its laboratories, Experimental Farms and Illustration Stations across the country and through its technical leaflets and bulletins, e.g., a common summer feature of extension work is the field day arranged co-operatively by the Dominion and Provincial staffs at one or other of the Experimental Farms or Illustration Stations, where new practices, new crop varieties and experimental results are seen by and explained to farmers.

The organization of advisory work varies in detail from province to province, but, generally speaking, there is an office in each county with one man and sometimes an assistant to do the work in that county. Normally there are not separate county or district advisers for poultry and horticulture, each advisory officer being responsible for these as well as for general farming. In practice, however, much of the horticultural production is in specialized areas, and in these areas the advisory officer is usually specially trained in horticulture.

Quebec, with more than one agronome (district or county advisory officer) to every one thousand farms, has the most intensive advisory service of any province in Canada. In some other provinces each county or district advisory officer (or agricultural representative, as he is commonly called) has

up to three thousand farms in his area, while in Canada as a whole each advisory officer has an average of slightly less than two thousand farms.

Quality of Produce No attempt will be made to describe all the work of the Dominion and Provincial Departments of Agriculture, but it would be remiss not to mention Canada's leading position in the standardization of agricultural products. This emphasis on quality, achieved largely through co-operation between agricultural producers and processors and the Government (but, in the last analysis, through compulsory grading and inspection), has been necessary to enable Canada to compete in distant markets against producers and processors on the spot and has been largely responsible for the high reputation built up in the United Kingdom for Canadian agricultural produce.

Government legislation to protect domestic consumers against low quality produce dates from before 1700, while as early as 1794 an Act was passed in Nova Scotia (then a separate colony) designating grades for, and providing for official inspection of, salted beef and pork for export. From 1800 onwards a number of Acts were passed in the different territories that now make up Canada, providing for grading and inspection of various products, including cereals, flour, pork, beef, butter, etc. In 1873 (six years after confederation), most of the previous legislation was consolidated in one Dominion Act. Since 1900 the scope and volume of the work has been broadened by a succession of different Dominion (and Provincial) Acts ; for example, at present the list includes the Canada Grain Act, the Fruit, Vegetables and Honey Act, the Maple Sugar Industry Act, the Dairy Industry Act, the Cheese and Cheese Factory Improvement Act, the Livestock and Livestock Products Act, the Cold Storage Act, the Meat and Canned Foods Act and others. Under these Acts, all the main agricultural products, including cereal grains, flour, livestock and livestock products, dairy products, poultry, eggs, fruit, vegetables and canned goods are subject to grading and inspection. Generally speaking, grading and inspection are compulsory for all products going for export, while in the case of home consumption they are compulsory for some products and voluntary for others.

The Acts mentioned also enable other aids to high quality to be provided by the Department of Agriculture ; premiums are paid on cheese above a certain standard of quality, arrangements are made for refrigerated railway cars for transporting butter, cheese and eggs, construction of cold storage warehouses is subsidized, and the operations of processing plants are supervised.

The Marketing Service of the Dominion Department of Agriculture is a large organization responsible for the grading and inspection and other aids to quality mentioned above in respect of products for export and for despatch across provincial boundaries. The Provincial Departments of Agriculture have the authority in respect of products which are produced and remain within their boundaries, but in many cases they use the same grade standards as the Dominion Department and either authorize the Dominion inspectors to do their work too or co-operate with them so that a uniform policy can be carried out for all products.

Efforts to ensure uniform high quality products are not confined to marketing alone. The Production Service of the Dominion Department of Agriculture and the Provincial Departments of Agriculture are striving to raise quality at the production end; e.g., the litter-testing stations across the country and the Advanced Registry Service for swine have done much in the last twenty years to raise Canadian bacon to its present high standard. Many other examples of this type of work could be quoted, such as the certification and distribution of pedigree seeds, animal disease control work,

and financial assistance to breeders for high quality sires and to agricultural shows and exhibitions.

Altogether it may be said that Canada is justly proud of her achievements in producing and marketing agricultural products of high quality.

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SELECTIVE WEED CONTROL IN CARROTS AND RELATED CROPS

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As soon as it was learned that in both American and Australian field trials annual weeds in carrot crops had been successfully killed by spraying with light mineral oil fractions, similar investigations were initiated in England during 1945, as part of the programme of research on weed control supported by grants from the Agricultural Research Council. At that time the oils which had been used extensively abroad appeared to come within the range of burning or vaporizing oils. For the first tests the oils of these types most readily available were Pool burning oil and Pool tractor vaporizing oil, but it soon became clear that the specifications which satisfied requirements for oil stoves or tractors were by no means sufficient to ensure that such oils were effective and selective herbicides for killing annual weeds in carrots.

Finding the Most Effective Mineral Oil That there should be considerable variability was not altogether surprising, since, in the procedure of storage and handling under war-time conditions, oils from different refineries in the world were bulked together. Some of the difficulties that arise when oils are either mixed together or selected by chance are well illustrated by the results of one of the early experiments. A comparison was made between a standard tractor fuel and mixtures containing a quarter, a half, and three-quarters of burning oil. These were sprayed on seedling carrots infested with annual meadow grass (*Poa annua*), and the results of counts subsequently made on both the weeds and the crop are set out in the following table.

Comparative Efficiency of Vaporizing Oil, alone and mixed with Burning Oil, for the Control of Annual Meadow Grass in Seedling Carrots

Proportion of Oils by Volume		Total Aromatics	Percentage Kill	
Vaporizing	Burning	Percentage Content	Annual Meadow Grass	Carrots
100	0	20.0	98	85
75	25	18.3	97	0
50	50	16.5	80	0
25	75	14.8	69	17

The experimental findings can be summed up as follows : with a chance selection of tractor fuel one may kill all the weeds and most of the carrots, while by mixing tractor fuel and burning oil in various proportions one can kill some of the weeds and some of the carrots or all the weeds and none of the carrots. At this period of the investigation it was generally held that the selectivity of the oils was linked with the "aromatic" content. When the aromatic content was too high there was a risk of killing the carrots, and when too low the weeds were not destroyed. Re-examining the results from this viewpoint, it is clear that this approach is not very revealing. It is the oils with the highest and lowest aromatic content which have caused the greatest injury to the crop.

Further experiments carried out in 1946 and 1947 confirmed that the suitability of an oil could not be judged on the aromatic content alone and that the variation within vaporizing or burning oil samples was too great to warrant their use being recommended generally. On the whole, the burning oils failed to kill the annual weeds, while the vaporizing oils—although more effective against weeds—tended to kill or check the carrots. It is not implied, however, that this was invariably so, because in most of the tests with tractor fuel the benefits of weed suppression offset the check to the crop.

At this stage of the work it was evident both from the English research and parallel investigations proceeding in California and elsewhere in the United States that there was unlikely to be any quick solution to the problem of what constituted selective toxicity in an oil suitable for spraying carrots. This slow progress was hardly surprising, since any petroleum fraction contains a large number of highly complex compounds and the time taken to separate the effects of the different constituents in a range of oils was certain to be very long and the results largely unpredictable. The short-term alternative was to find out empirically by field tests which oils were truly selective in their action and then to ensure that carrot growers received as nearly as possible the same material.

The establishment of this linkage between the experimental tests and commercial practice presents comparatively little difficulty in America, where there are many indigenous oilfields and local refineries ; to maintain continuity in grade and performance, supplies of crude oil can be drawn from a single oilfield and refined into fractions under standard procedures in a single refinery. On the other hand, petroleum products reaching England normally come from oilfields all over the world, and most of the refineries are situated abroad. Therefore, before the research could be continued, oil fractions from specific oilfields and refineries had to be imported specially. As it was possible only to guess what fractions were required, and clearly impossible to test samples from all the larger oilfields and refineries, a selection had perforce to be made. Amongst the oil fractions not yet tested there may, therefore, be some which are equal to or better than those already investigated, and research on a wider range of oils is now being carried out.

The fractions already investigated (apart from burning and vaporizing oils) include kerosenes with a low aromatic content (0.5 to 6.6 per cent), kerosene extracts with a very high aromatic content (75–85 per cent) and more volatile fractions coming into the category of "white spirit" or "Stoddard solvent," which are normally used for dry cleaning and as paint thinners. These volatile oils were included because it has been found in the U.S.A. that with them there is less risk of imparting an oily flavour to the carrots, even if spraying is delayed until the seedling stage is past. On the other hand, it was realized that such oils in England carry a tax

of 9d. a gallon and that their cost would, therefore, be very high for field-scale use.

So far it has been found that mixtures made up of kerosene extracts and kerosenes with a low aromatic content have killed the widest range of weeds. In fact the best of them were superior to any of the "straight" oils, including a Stoddard solvent type which has been used extensively for weed control in carrots under American conditions. The proportion of kerosene extract must be kept within well defined limits since, undiluted, they are far too toxic to carrots. The optimum results have been obtained by using 15–20 per cent by volume of an 85 per cent aromatic kerosene extract* and 80–85 per cent by volume of either of two low aromatic kerosenes.†‡

Susceptibility of Annual Weeds and Time of Application Amongst the annual weeds which are relatively susceptible the following are listed in approximate order of increasing resistance: annual meadow grass (*Poa annua*), chickweed (*Stellaria media*), speedwells (*Veronica* sp.), fat hen (*Chenopodium album*), henbit dead nettle (*Lamium amplexicaule*), spurrey (*Spergula arvensis*), orache (*Atriplex patula*), shepherd's purse (*Capsella bursa-pastoris*), poppies (*Papaver* sp.), yellow charlock (*Sinapis arvensis*), and annual nettle (*Urtica urens*). Sow thistles (*Sonchus* sp.), fumitory (*Fumaria officinalis*) and groundsel (*Senecio vulgaris*) appear to be very resistant once the plants have attained any size, although a reasonable control of the last two can be achieved by spraying when the plants possess only two to four true leaves. It is not implied, however, that spraying of the more susceptible weeds should be delayed, because the highest degree of weed control will invariably result from spraying as soon as the risk of damaging the carrots has passed.

It is not safe to spray carrots before they possess at least two true leaves, and spraying should cease *before* the plants have developed tap roots as thick as a lead pencil. This is not because the carrots would be damaged by late spraying but because traces of the oil would persist in the plants until harvest time and cause a "taint". Where spraying has been carried out in the early seedling stage, no taint has been detected in maincrop carrots with the oils so far tested. On the other hand, there is a very distinct risk with spring-sown carrots pulled and bunched for the early market that the taint will make them unsaleable.

It seems immaterial whether the foliage of the weeds or the carrots is wet or dry at the time of spraying, since equally good results have been obtained under both conditions. Spraying is more or less "weatherproof", as effective action is not interfered with by rain after treatment. Nor is temperature a factor of importance, except that there is a risk of damaging the carrots if spraying is carried out in very hot weather.

Rate of Application There remains the question of the quantity of oil that is required to give the best results, and here further research is needed. At present it would appear that if the whole area and not only the carrot rows are to be sprayed, 70–100 gallons of oil

* Shell Medium Kerosene Extract ex Digboi. Specific gravity 0.925, initial boiling point 224°C., 50 per cent distillation 255°C., final boiling point 290°C.

† Shell Odourless Kerosene. Specific gravity 0.795, initial boiling point 198°C., 50 per cent distillation 238°C., final boiling point 269°C., aromatic content 0.5 per cent.

‡ Manchester Oil Refineries Kerosene W.B. Specific gravity 0.842, initial boiling point 138°C., 50 per cent distillation 205°C., final boiling point 273°C., aromatic content 6.6 per cent.

per acre are needed. If, on the other hand, the carrots are grown in wide rows with inter-row cultivation, the quantity of oil can be decreased by arranging for the individual nozzles on the spray boom to spray single rows, leaving the weeds between the rows to be dealt with by the hoe.

Whatever practice is adopted, the weeds must be completely covered with a film of oil. The rate of application will depend on the stage of growth —susceptible weeds in the young seedling stage may be killed at lower rates than those required by older plants. Once the weeds have reached a height of 5–6 inches, however, little useful reduction in weed cover can be expected, even at the highest rates of application.

When this investigation was started it seemed that the costs of spraying could be greatly reduced if oil-water emulsions could be substituted for undiluted oils. Unfortunately, experiments carried out in 1945-46 produced some surprising and disappointing results. It was found that emulsions were less effective in killing the weeds and much more toxic to the carrots. For example, in one experiment in which an undiluted oil had no effect on carrot seedlings and gave a 98 per cent control of annual meadow grass, a half-and-half emulsion of oil and water destroyed 53 per cent of the carrots and only 65 per cent of the meadow grass—a very interesting result as regards the analysis of toxic action, but hardly one which can contribute to the saving of oil during spraying.

These experiments have been extended to cover the possibilities of weed control in parsnips, and the conclusions reached are very similar to those for carrots. It is essential to spray when the parsnips are young plants with two to four true leaves, and some check to growth may result, for parsnips are rather less resistant than carrots. However, the check does not normally lead to any appreciable reduction in yield at harvest.

Although no experiments have been undertaken at Oxford on weed control in parsley, reports have been received from growers that tractor fuel has given good results when sprayed on the young plants; in view of the great variability in the behaviour of tractor fuels, however, caution is required. The use of the mineral oils at present available is not recommended for weed eradication in celery: the crop is too susceptible.

As the recommended mixtures of oils may not immediately be available in large quantities, growers may wish in the meantime to try out tractor fuel. If this step is taken the only rational policy is first to obtain a bulk consignment well in advance and to try a small quantity on an experimental patch as soon as possible; only if it is clear after about three days that results are satisfactory should the whole field be sprayed. By this means a loss of crop may be avoided, and an oil which fails to kill the weeds in the initial trial can be used in the tractors.

There is little to be said about the actual technique of spraying except to emphasize that rubber diaphragms, hoses, and tanks with rubber linings will be attacked by these oils unless they are made of special oil-resistant mixes. However, in the case of diaphragms and hose eventual replacement is not an expensive item.

MECHANIZING THE CARROT CROP

F. M. Darby, N.D.A.

Norfolk Agricultural Executive Committee

THE carrot crop makes heavy demands upon manual labour, both during cleaning operations and at harvesting. The possibility of mechanizing the crop has consequently been investigated on a light, black fen soil in west Norfolk, where carrots are an important crop and

yields of over 20 tons per acre can be grown easily. Unfortunately, weeds grow vigorously on this type of soil, and the area concerned, being part of a large area of reclaimed fen, is only thinly populated and labour is scarce. The future of the crop in the district thus depends upon an early solution of the labour problem by controlling weeds, by spraying as distinct from hand weeding, and by harvesting mechanically.

To facilitate both operations, drill widths have been standardized to allow easy inter-row cultivations, the reduction of spraying fluid per acre, convenient mechanical harvesting and the possible safeguarding of the crop against light frosts.

A double row system has been adopted, the seed being drilled in two rows 7 inches apart, with a space of 17 inches between each double row. Other row spacings have been tried, but on the type of soil concerned carrots grow to a considerable size ; with spacings less than 7 inches the carrots tend to push one another out of the ground, and it is difficult to remove the tops by mechanical methods. The seeder type of drill, made originally for America but now used in this country, has been found very suitable for carrots, since the flow of seed is regular and, as the drill units are independent, depth control is accurate. Usually these units are more than 7 inches wide, so that for the double row system it is necessary to fix them on a tool-bar in echelon. This is not difficult; and a tool-bar fixed to a tractor with a hydraulic lift makes a useful outfit.

Weed Control Previous experience on this fenland soil has shown that hand weeding must be carried out at least twice, and often three times, in a wet season. Spraying with paraffin, however, although not entirely eliminating the necessity for hand weeding, has reduced it considerably. For the past two seasons commercial P.V.O. has been used, but it will be appreciated that the oil companies operating in this country have little information concerning its weed-killing properties. It has been found essential to experiment on a small area with a sample from each P.V.O. consignment before spraying the whole field. This is most important, otherwise it may be found that either no weeds have been eradicated or that both weeds and carrots have been killed.

The rate of application necessary for a satisfactory kill of weeds depends on their stage of growth, the degree of infestation, and also upon atmospheric temperature. Good results have been obtained even by spraying during rain, but the weeds are slower in dying and a high rate of application (up to 70 gallons per acre) is necessary. On a warm day, with a moderate weed infestation at the seedling stage of growth, very satisfactory kills have been obtained by using approximately 30 gallons of P.V.O. per acre. It may, therefore, pay to await favourable conditions unless weed growth is excessive and vigorous.

This reduction in the quantity of P.V.O. is also rendered possible as a result of the double row drilling, since the spray nozzles can be adjusted to cover the two 7-inch rows and leave the intervening 17 inches to be dealt with by tractor hoeing. Spraying is most effective whilst the carrots are in the two-leaf stage and weeds are small, but the operation can be delayed if the crop is not required for early pulling. Late spraying, however, should be avoided, since crop growth is checked for approximately a fortnight, and there is also the risk of taint. For early bunching carrots, a light proprietary mineral oil is available which should cause no tainting, but it is fairly expensive for the ordinary grower.

Most common fenland weeds are killed—even chickweed, if it is not too large. Fat hen and annual nettle are rather more resistant, but even

these are severely checked and most of them are killed if sprayed when small. Almost any type of spraying machine can be used, but one mounted on a self-propelled drilling and hoeing unit has proved very suitable. Some trouble has been experienced owing to the effect of the oil on the rubber pump valve washers, but this has been overcome by substituting leather washers. The diaphragm and the rubber will last a whole season without replacement, provided a few gallons of water are pumped through the machine at the conclusion of each day's work.

Harvesting Removal of the carrot tops is essential when harvesting is mechanized, and last year a small engine-driven grass mower was used to cut one double row at a time; this was followed by a light three-row baulk harrow to pull the tops into line across the fields. The tops are then heaped by hand, prior to carting to the harvested portion of the field. This year attempts will be made to use a side-delivery rake to simplify the process, but it may prove difficult to prevent the carrots from being scratched out of this light peat soil by the tines.

Following the clearing of the tops, four rows of carrots are pushed together by a small machine with two shares fashioned like large "L" hoes, which turn two double rows of carrots into the intervening 17-inch space. This small implement is mounted directly to a tractor with hydraulic lift, and two men can easily carry out this operation as well as harrowing the tops ahead of the harvester. A potato harvester of the type employing an elevator digger chain, with side elevators leading the crop past a sorting platform and finally into trailers, has proved very successful for lifting, averaging 1½ acres per day on a 20-ton crop. A few small carrots may find their way through the elevators, but the quantity does not exceed that left by hand workers. The harvesting machine itself is operated by one man, with four women around the sorting platform removing odd tops and debris.

The complete system outlined above has been in use for only one season, but it is expected that with greater experience, both with spraying material and in technique, and with further developments of root harvesters, greater progress in the mechanization of the carrot crop will be possible.

WHERE THE HORSE SCORES

T. Jesse Wadlow

Much Wenlock, Shropshire

IF the slaughter of foals and other young horses is allowed to continue unchecked, some farmers may get as desperate as the king who exclaimed when in dire need, "My kingdom for a horse!" However, if there were not a farm horse in the country there are farmers who would not worry as long as they were assured of tractors and the fuel and spare parts to keep them going. At the present time the outlook for supplies of these is fairly good, but it is plain that in the event of any disruption of supplies, whatever the cause, farmers owning agricultural horses would be in a more favourable position than those without them.

Adaptability But taking for granted the certainty of supplies of tractor paraphernalia, the horse still remains a valuable aid to farming. One advantage in his employment is that on occasions he can be used for urgent work when the use of tractors would be practically impossible. During the great freeze-up and exceptionally deep snows of

1947 we could not carry out any useful job with a tractor in our district, but the unshod horses proved invaluable in getting food to the livestock, difficult though it was.

Perhaps the farm draught horse shows to best advantage when, around seed times, cultivated land is too wet to carry tractors without harming the tilth, though dry enough for horses. For example, this year we thought early February too early to sow barley on rather strong land 800 feet up. But later, when we did want to sow, a toe forced into the soil indicated that it was not friable enough under the surface to be compressed by tractor wheels; yet it was dry enough for horses. As we did not possess a horse drill we had to wait a fortnight before the field could be sown by tractor.

In fairness to the machine it must be admitted that the extra compression of the soil by the tractor, when dealing with ploughed-up turf and leys, may sometimes be advantageous, because consolidation is then very important—especially for wheat. On very rich soils it may even be desirable to compress heavily with tractors by carrying out cultivations when the soil would ordinarily be considered too wet for them. A similar idea used to be put into effect many years ago by repeating harrowings with horses abreast. Pressure on the soil in such circumstances injures its structure sufficiently to reduce the straw of the crop; in this way lodging is prevented and in consequence the crop yields better. In no case, however, must the soil be so wet as to become puddled, or the grain will neither germinate nor yield well.

Economic Comparison Until 1943 I used one tractor and four or five horses on 200 acres of arable land. Now we use two tractors and two horses on 216 acres and do not seem to get the work done much quicker than before, although much depends on the dryness or otherwise of the season. The tractors are particularly valuable in getting as many fields as possible ploughed over (some only lightly) immediately after harvest, while the two horses do the odd jobs. This enables the tractors to make an uninterrupted thrust at this very important work.

Two tractors and four horses for 200–250 acres of arable land (with proper rootbreaks and short leys) would, I think, be ideal if a good horseman were available. It would be economical to keep the one tractor (nearly new) and the four horses at work as continuously as possible, using the other tractor (an older one) at busy times only. For half the above acreage one tractor and two horses would suffice, but one of the horses might possibly be a breeding mare. In the first case two or three of the horses might be young ones, which—unlike the tractor—would be "growing into money".

When as many as four horses are kept they must carry out some of the heavier cultivations in order to justify the expense of keeping them, and an experienced horseman becomes indispensable. When only two horses are employed, however, they need be used only for the many light jobs and light cultivations which have to be encompassed on every farm, and unskilled or semi-skilled workers are all that are necessary.

Some of the jobs that occur to me for which two horses, under conditions too wet for tractors, can be used, are: drilling beet and other root crops with a drill which scoops the soil upon the seed; drilling wheat with a disc drill; harrowing for various purposes, but especially for covering seed wheat; horse-hoeing clean roots, or even weedy ones the first time over when two hoeings before singling are intended; light rolling; chain harrowing; rolling leys and turf; carrying corn to safety from the combine harvester after heavy thunderstorms; broadcasting MCPA. All these are operations which horses can do without appreciably harming crops or

soil at times when it would be unwise to attempt to carry them out with a tractor. In this way the farm work is kept going without causing "hard places" all along the fields, as tractors are apt to do.

It is generally proclaimed that one of the main reasons why horses are in disfavour is that men who can manage them efficiently are unobtainable, yet one of the reasons why some of us like a few horses is that they can lie out and be fed and driven by unskilled male and female workers. Only when as many as four good working horses are maintained does it become necessary to employ an experienced teamsman regularly.

Undoubtedly draught horses are an asset to farming, and it is extremely helpful to have them at hand in wet or wintry weather for jobs which the tractor is unfit to do. In addition it is advantageous to be able to call upon them for the large amount of dry weather work which they can do so economically. They should not, therefore, be dispensed with just to save the little trouble attached to their organization. Farm horses can be counted an important national asset.

COLORADO BEETLE IN ENGLAND, 1948

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IN 1947 the number of occurrences of Colorado beetle breeding on potato crops in this country was the highest ever recorded and, as mentioned in the account of the situation in that year,* preparations were made to meet further attacks in 1948. As it turned out, however, 1948 provided a welcome contrast, and only 11 instances of breeding colonies were reported compared with 57 the year before; finds of single beetles within the country unassociated with potatoes were also much fewer, though many more were intercepted on ships. Except in a few instances where the evidence was inconclusive, inquiries showed that the single isolated beetles found had come from the Continent with imported produce or on passenger ships, and the small number of field occurrences of the pest indicates that the measures taken in 1947 had been on the whole successful.

It will be convenient to discuss separately the finds of single beetles, those intercepted on ships, and the occurrences of breeding colonies on potatoes in fields and gardens.

Finds of Single Beetles The first discovery of the year was at Bromley, Kent, where on January 18 a beetle was found in a private garden near some bushes which were being dug up and removed; a thorough search at the time and later in the year failed to reveal any more. The second find was a dead beetle discovered on February 5 among old clothes in a travelling trunk from Germany; another dead beetle was found on February 25 with camomile flowers of Belgian origin.

The first live beetle associated with imported produce was found on February 14 in Nottingham market on lettuce from the Perpignan district in the south of France. Subsequent reports of single beetles on or associated with lettuce from the south of France were received from Torquay (March 24), Leeds Market (March 27) and Smithfield, London (March 31). Imports

* *Agriculture* (May, 1948), 55.

from France of lettuce and other green vegetables with foliage likely to harbour Colorado beetles ceased on March 31. On March 25 a single beetle was discovered on Dutch imported lettuce at Mill Hill. Two others were found during the month, one on lettuce at Wembley and another on an allotment field at Wendover ; the origin of these could not be traced with certainty.

During April two beetles were found in a greenstuffs depot at Newcastle and one on a consignment of mixed English and Dutch lettuce at South Shields. On April 28 a report was received of the arrival at a London goods yard of two closed truckloads of Italian lettuces ; on inspection, thirteen Colorado beetles were found on a fraction of this consignment and both vans were immediately locked, sealed and re-exported. It was calculated that if the remainder of the consignment was uniformly infested to the same extent as the sample examined, the two vans probably contained about 2,000 beetles.

Consignments of lettuce from Holland received during the last few days of April continued to be handled until about May 5. During this period four single beetles were found on or associated with Dutch lettuce—all in the London area. The origin of four other beetles found in early May could not be traced with certainty. After this period a few more single beetles were found on such products as fruit and onions, bringing the total for the year associated with imported produce to 38.

Beetles intercepted on Ships and at Ports It is now well known that beetles can arrive on cross-Channel boats of any type and with any kind of merchandise. The first beetle reported on a cross-Channel boat in 1948 was on May 17 on the S.S. *Redstar* with a cargo of machinery, copper and oil from Antwerp. On the following day the master of the S.S. *Falaise* reported the finding of a number of beetles on board ; this ship had been on a weekend cruise to the French coast and up the Seine. By the time she berthed at Southampton 29 beetles had been handed in by passengers and 8 more had been killed by the crew ; the decks and superstructure had been thoroughly washed down and an intensive search revealed only one more. Reports of one or more beetles on ships or at ports continued to be received throughout May and the first week of June, culminating on June 8 with reports from the masters of four cross-Channel vessels of the destruction of a number of beetles which had been seen to alight on the ships when they were within a few miles of the French coast. In the case of the S.S. *Hampton Ferry* ex Dunkirk, the insects flew aboard when the ship was in the Dunkirk Channel, about five miles from the French coast ; in all 60 were found on this vessel. On the S.S. *Dinard* ex Boulogne "about two dozen" beetles were killed and three were handed to Customs Officers. About 30 were found on the S.S. *Prince Albert* ex Ostend, and an unknown number were killed on the S.S. *Sheperton Ferry* ex Dunkirk. For the next few days beetles were reported on other ships which had been bound for ports in this country from the Continent on June 8 and 9, and there were undoubtedly considerable flights from the Continent out over the sea at this time.

Throughout the remainder of June and during July and August single beetles or small numbers continued to be reported on cross-Channel boats and at the ports, and mention should be made of finds of a few beetles on ships arriving at Liverpool from Spain.

In addition to beetles intercepted on ships from the Continent, it is interesting to record finds on transatlantic shipping ; one beetle was found in mid-Atlantic on the S.S. *Aquitania* bound for Southampton. At West

Hartlepool, Barry and Cardiff respectively on three separate days in July a single beetle was found on cargoes of Canadian pit-props which were being unloaded or which had just been unloaded. On October 4 a dead beetle was found on the American S.S. *Joseph Lee* from New Orleans, and another on November 1 among ship's store potatoes on S.S. *Captain Polemia* with a cargo of timber from Canada.

The last live beetle was found at Cambridge on December 3 on lettuce believed to have been imported from Perpignan. Finally, on December 21 a sealed jar containing an uncounted number of dead beetles was handed in; this had been washed ashore on the Winchelsea beach on December 3 and it is thought that these were beetles collected and killed somewhere on the Continent and subsequently thrown into the sea.

During the year two beetles were found in aircraft—one on June 10 at Northolt in an aeroplane from Brussels, and another on June 28 at London Airport in an aeroplane about to leave for Paris.

The totals of single beetles found during 1948 were :

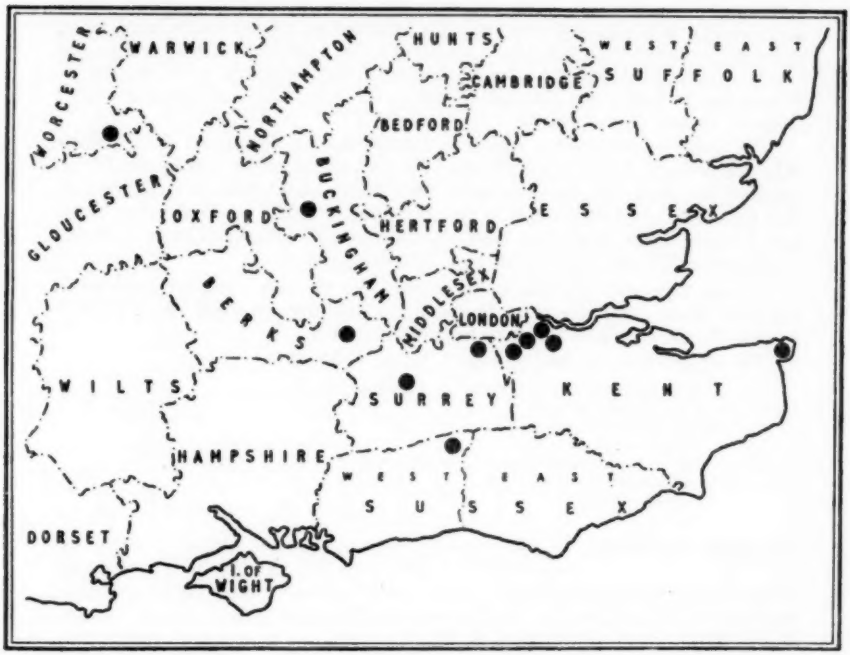
Associated with or on imported produce	38
Intercepted on ships	279 (+)
On docksides and beaches	11
Inland on crops, etc.	17
Others (odd dead beetles, not including those washed ashore in a jar)	7
On aircraft	2

Breeding Colonies Of the eleven breeding colonies found in 1948, five were in Kent, two in Surrey, and there was one each in Berkshire, Buckinghamshire, Sussex and Worcestershire. It is of interest that none was reported in Bedfordshire or Hertfordshire, where a number of attacks gave cause for alarm in 1947.

There were four discoveries before the end of May, the first as early as May 12-14 when, during a hot spell, eight beetles were found on or near a plot of parsnips at Wisley, Surrey. There were no potatoes in the field, and none had been grown there for the past five years. Volunteer potatoes from elsewhere were planted on the plot as traps, and early in June two further beetles and some batches of eggs were found on these plants. Nearby crops were searched repeatedly without result, and then dusted with DDT : nothing further was discovered during the year. It is difficult to account for this occurrence, and the only likely theory that can be put forward is that there may have been an undetected colony in 1947 on black nightshade (*Solanum nigrum*) plants growing on a compost heap which, during the winter, had been spread on the plot where most of the beetles were subsequently found. Black nightshade is one of the few British wild plants on which Colorado beetles and their grubs can feed.

The next occurrence was on May 20 at Winkfield, Berkshire, on a plot sown with onions, on which potatoes had been grown the year before. There were a number of volunteer potatoes on the plot, and some 60 beetles, with many batches of eggs, were found in the next few days—undoubtedly the progeny of a colony which had not been noticed in 1947. The usual measures were taken, including inspection or spraying of all potato crops within two miles ; nothing further was found.

A day or two later, a few beetles were seen on volunteer potato plants among beetroot and carrots on a smallholding at Bengeworth, near Evesham, 8 beetles and some batches of eggs eventually being found within an area of 150 square yards. Constant watch was kept on this plot and careful search of all potatoes in the neighbourhood led to no further discovery, so presumably the beetles were the progeny of a small colony undetected in 1947. All



Map showing location of breeding colonies of Colorado beetle found in 1948.

potato crops in the area were dusted with a DDT insecticide. The last find in May was at Broadstairs, Kent, on early potatoes in a garden where there had been an attack in 1947. Twelve beetles and about 30 batches of eggs were discovered; one batch of eggs was beginning to hatch on May 31.

On June 11, the discovery of 10 beetles and some batches of eggs on volunteer potatoes in a field of lettuce and peas was reported at Kevington, near St. Mary Cray, Kent, not far from several occurrences in 1947. On the same date beetles and eggs were reported in a large garden at Quainton, Buckinghamshire, partly on volunteer potatoes and partly on the 1948 crop; in all, about 20 beetles and 50 batches of eggs were found. Later in the month, some eggs were found on potatoes in a school garden at St. Paul's Cray, where there had been a colony in 1947. This and the occurrence at Broadstairs mentioned above are the first instances in which beetles have appeared on sites dealt with in the preceding year.

The next occurrence was on July 13 when a beetle was found on a volunteer potato plant in a field partly planted with lettuce at Dartford, Kent. Search by temporary inspectors showed that numerous grubs were feeding on other volunteer plants over an area of about ¼ acre, and the area was dusted with DDT and injected with carbon disulphide. The only other discovery in July was near the end of the month, when a few grubs were found on potatoes on an allotment at Norbury, London.

No further discoveries were made until August 20, when some beetles were found on volunteer potato plants in a field of cabbage at Darenth, near Dartford. There was no sign of eggs or grubs despite careful search, nor

was anything further found on potato crops in the area. Finally, on September 18, a beetle was found in a 3-acre field of potatoes at Broadbridge Heath, near Horsham, Sussex. The haulm had already been removed and lifting of the crop was carried out under supervision ; nothing further was found. There might, however, have been a colony in this field earlier in the season, and, as a precaution, this was regarded as a case of "beetles breeding".

It will be noted that all the occurrences were on a very small scale and that most of them were on volunteer potatoes, suggesting the presence of colonies on the preceding year's crops and indicating that beetles which emerge in the spring tend to remain on the nearest available food plants. The measures adopted to eradicate the colonies were the same as in 1947 ; they are described in the article in this JOURNAL referred to above. "Trap" crops of potatoes will be grown on the sites this year and will be inspected regularly ; precautionary spraying or dusting of potato crops will also be carried out in the surrounding areas.

Spraying Campaign Field-scale spraying and dusting of potato crops was again carried out for the Ministry by Plant Protection Ltd. Just over 29,500 acres were treated—an acreage nearly three times as large as in 1947 ; of this, all except 177 acres was "precautionary" treatment, planned beforehand. Because of the concentration of occurrences of the beetle in 1947 in the northern half of Kent, all potato crops in the county north of the Folkestone-Tonbridge line (about 20,000 acres) were included. DDT emulsion was used on about 6,000 acres, DDT dust on 7,668 acres, and the remainder received lead arsenate spray. Twenty-seven tractor-mounted spraying machines and twelve dusting machines were employed, in addition to hand sprayers and dusters for small areas. The operations were carried out under difficult conditions because of poor weather, rain often causing delay; an excessive growth of haulm in some areas added to the difficulties. In spite of this, the spraying machines covered an average of $28\frac{3}{4}$ acres per day and the dusting machines just over $33\frac{1}{2}$ acres per day.

Effect of Weather Weather conditions throughout 1947 had been exceptionally favourable for multiplication of the Colorado beetle. It was known that large populations had been built up at the end of the season on the Continent and that great numbers of beetles of the second generation had gone into hibernation. In the spring of 1948 conditions were again favourable and successful emergence of overwintering beetles took place on a large scale. This was confirmed by the flights that occurred on and near the French, Belgian and Dutch coasts in May and June, resulting in beetles coming down into the sea in large numbers and being washed ashore on the Continent in masses. It is not surprising, therefore, that some beetles reached this country with imported vegetables or other produce in the early part of the year, or that a few were washed up on our coasts. Following the mass flights, there was, as in 1947, a sea-borne invasion of Jersey, but there was again no evidence whatever of direct flights from the Continent to the Channel Islands or to England.

During the remainder of 1948 the weather on the Continent was cold and wet and did not favour the beetle. A high proportion of the young grubs perished, and this, combined with the effects of active control campaigns in the countries affected,† led to a greatly reduced second generation, estimated,

† V. E. WILKINS. International Scheme for the Control of Colorado Beetle. *Agriculture* (October, 1948), 307.

in the area near Paris, to have been not more than one-sixth of the numbers in the preceding year. Similarly in England the weather was our ally, and there is at present less reason to fear the early establishment of Colorado beetle as a pest in this country than there was at the end of the 1947 season.

Action this Year There are, however, no grounds for complacency or relaxation of effort, and preparations have been made by the Ministry for precautionary spraying or dusting of potato crops in the danger areas in 1949 on about the same acreage as last year. The co-operation of farmers and the general public is as necessary as ever in reporting any occurrence, or suspected occurrence, of Colorado beetle at once to the police or to officers of the National Agricultural Advisory Service, or direct to the Ministry's Plant Pathology Laboratory, Milton Road, Harpenden, Herts.

We shall be able to prevent the pest gaining a foothold only by continued vigilance and prompt notification of discoveries so that the necessary steps can be taken immediately. It is again emphasized that if a colony of grubs or beetles is found and reported nothing more should be done until the arrival of an officer of the Ministry. The co-operation and help received in 1948, especially from the masters and crews of ships calling at Channel ports and from the police, is gratefully acknowledged by the Ministry, and once again an appeal is made for its continuance. Tribute is also paid to the excellent work of the temporary inspectors employed during the summer, and to the staff of Plant Protection Ltd.

STORING FERTILIZERS IN CLAMPS IN THE FIELD

Clamping bags of fertilizer in the open is feasible and has several advantages. Early delivery of fertilizers can be taken, thus making sure of supplies and benefiting from the rebate allowed for summer purchasing. The bags of fertilizer can be stored on the fields which it is intended to manure ready for use in the following season: this avoids handling them twice.

The method was first described by a Lincolnshire farmer, Mr. C. W. Parker, in the *Lindsey W.A.E.C. Bulletin* (Winter, 1944) and it has been adopted successfully on several Lincolnshire farms for a number of years. Tests of the method carried out in the 1946-47 and 1947-48 seasons on Mr. C. A. Major's farm at Atterby Carrs were reported in the *Fertiliser and Feeding Stuffs Journal*, June 30, 1948. The procedure used on Mr. Major's farm is as follows:

A 3-feet bed of straw (or straw bales) forms the base of the clamp, and the fertilizer bags are placed flat, side by side, in pyramid fashion, thus:

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With six 1-cwt. bags at the base, each pyramid contains about a ton, and the whole clamp about 18 tons of fertilizer. The pile is covered with a 2-feet layer of straw (or, preferably, straw batts—sheaves of straw bound with twine in a device employing a binder knotting mechanism), topped with dyke cleanings (i.e., waste vegetation —weeds, hedge clearings), the whole being secured with a stack net. No soil is used. All the clamps are sited on well-drained soil but no special precautions are taken regarding drainage.

These notes are based principally on experience with granulated fertilizers (National Compound No. 1, granulated, in 5-ply paper bags) which come out of the clamp in a good friable condition and are easily distributed. Non-granular fertilizers, however, are also clamped regularly and successfully on Mr. C. W. Parker's farm. On this farm additional protection in clamping is afforded by the use of old fertilizer bags trapped along the outer rows of bags between successive layers of the pyramids, so that the used bags hang down and form a sheet over the whole.

GRASS SILAGE FOR WINTER FATTENING OF BULLOCKS

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THIS article is intended primarily to give the results of a feeding trial with fattening bullocks fed on grass silage at the Agricultural Research Institute, Hillsborough. In view, however, of the great interest now attaching to grass production and conservation, it may be useful in the first place to give a short account of the experience gained in making grass silage at the Institute during the past two years.

In 1947 investigational work was started at the Institute to see how far the production of grass silage could be fitted into general farming practice in Northern Ireland. In planning the programme, various factors were taken into consideration, such as the provision of a simple, yet efficient, silo which could be filled easily, the mechanization as far as possible of the field operations to reduce labour, and the production of grass silage with a minimum loss of food nutrients.

Trench Silos In the light of previous experience with many different types of silo, it was decided to use the trench silo because of its low cost and ease of filling ; also because it was a type which could be recommended for use by the average farmer. Consideration was also given to the site for the silo. During the winter months in Northern Ireland, cattle are usually housed in and around the farmyard. Thus it seemed that the proper place for the silo was near the farmyard, so that the labour involved in emptying the silo and feeding the silage would be reduced to a minimum. Accordingly two trench silos have been made side by side in the stackyard, adjacent to the stock buildings, with one end adjoining the main road and the other end opening out to hard ground. This ensures that the approaches to the silos are always firm and reasonably clean, and filling can proceed without interruption and waste of time. The tractors and other vehicles enter from the main road, and loads are emptied while passing through the silos, thus giving continuous compaction of the herbage during filling.

The capacity of each silo was limited to 50 tons to serve as a demonstration of the type of silo suitable for small farms, but at the same time the construction has been such that the capacity can readily be increased. Moreover, experience has shown that even on large farms it is better to have two or more small silos than one large silo, so that each can be filled and finished off as material—whether arable crop or grass—becomes available during the season.

These silos have aroused considerable interest amongst farmers, and many similar ones have been made throughout Northern Ireland, modified according to differing conditions and circumstances. As a matter of interest, therefore, some of the more important details of dimensions, etc., are given below, with brief remarks on special features and improvements which might be made as a result of experience gained during filling operations.

Length	43 feet
Height of concrete side walls	5 ,,
Width at top	12 ,,
Width at bottom	11 ,,
Capacity of each silo	45–50 tons freshly-cut grass

The bottom of each silo has a light covering of 1½-inch stones blinded with screen dust, and is not more than 2 feet below ground level at the centre. This shallow depth and the ramp at each end allows the silage to be removed easily in hand-operated trolleys or barrows. The height of the concrete side walls could with advantage have been 6 feet for a full 50 tons capacity. Each side wall has a slope 6 inches inwards from top to bottom, which appears to be sufficient for satisfactory consolidation of the herbage during sinking. No reinforcement was used in the side walls, which are perpendicular on the outside, with a thickness of 6 inches at the top and 12 inches at the bottom. Where, however, there is no outside support for the walls, light reinforcement in the concrete would be an advantage. Drain-pipes are placed at intervals through the bottom of the side walls; it is important that there should be free drainage of surplus liquid from the silos, and equally important that outside water should be prevented from running into the silos. No special roof was provided for the silos at the time they were made; this is a debatable point, and the question of a suitable cover for this type of silo under Northern Ireland conditions is still under investigation.

A.I.V. and Molasses In 1947 both silos were filled with grass from a four-year-old ley, the grass being cut by mower, raked into windrows and forked by hand labour into tractor-trailers and horse carts. The A.I.V. method of conservation was adopted for one silo, and the molasses method for the other. During the second half of May last year the two silos were again filled with grass—one with 51 tons 7 cwt. of grass treated with molasses at the rate of 2 gallons per ton, and the other with 47 tons 3 cwt. of untreated grass. The grass used was surplus to requirements at that particular time and was taken from three- and six-year-old leys, which were subsequently grazed for the remainder of the season. The grass was cut by mower and gathered direct from the swath by a green-crop loader into tractor-trailers.

The use of the green-crop loader reduced considerably the labour involved in filling the silos. In 1947 (when loading was done by hand-labour) 7.40 man-hours, 1.11 tractor-hours, and 2.0 horse-hours were needed for cutting, loading and filling each ton, compared with 4.72 man-hours and 1.97 tractor-hours with the use of the green-crop loader in 1948. Experience gained during filling operations last year showed that still further economies in labour could be achieved.

The cost per ton of green grass filled into the silos in 1947 was 23s. 5d. and in 1948, 22s. 5d. These are prime costs including only items of direct expenditure associated with production of the silage. Charges such as rent and overheads are not included. The margin of difference in cost per ton does not appear to reflect the saving in labour in 1948 as shown by the figures already given, because in that year (1) the grass was younger and shorter, and a much greater area had to be cut in order to fill the silos, (2) carting distance to the silos was much greater, and (3) labour costs were higher as a result of a substantial increase in wages.

Experiment with Shorthorn Crosses In the autumn of 1948 it was decided to use the silage made in the trenches to investigate the possibility of fattening bullocks during the winter on a diet consisting largely, or entirely, of grass silage. At the same time it was felt that if the bullocks could be finished satisfactorily, it might point to a means of making winter beef production more economic under existing price levels than when cattle are fed on traditional fattening

1. Preparing the ground for transplanting.

2. The seedlings are placed between two boards.

3. The seedlings are held in position by the boards while they are "lined out".

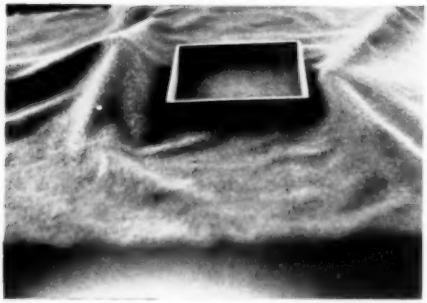
4. The roots are then covered and soil trodden down before the boards are removed.

Pine seedlings in a Forestry Commission Nursery at Rendlesham, Suffolk.

Seedbeds sown with beechmast, protected against pigeons by wire netting.

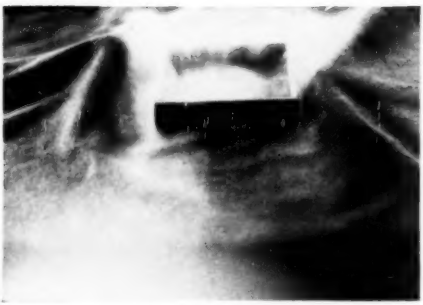
Photos: *J. D. U. Ward.*

FROST DAMAGE TO FRUIT (See pp. 86-90)

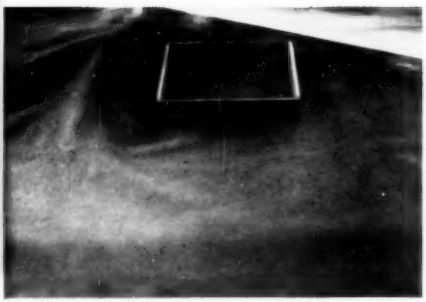


In the accompanying photographs, a small wooden frame represents the walls of a garden on a slope. Air, bubbled through liquid air, is led to the top of the slope, and on account of its high density it flows down the slope, forming a dense fog when it mixes with the surrounding air. The fog thus shows where the cold air flows.

1. Model of garden walls on a slope.



2. Cold air flowing downhill cascades over the top wall to fill the whole garden.



3. If the garden is protected by a diagonally-running wall, hedge or hessian screen, it is kept completely clear of cold air.

4. Walls set at an angle of about 45 degrees to line of greatest slope deviate most of the cold air, so that little of it enters the garden.

Photos. : *Professor D. Brunt.*

rations, or even on the foods which the average farmer can at present provide. For the purpose of the experiment ten bullocks were purchased at the beginning of December. They were mainly Shorthorn crosses of good type and in forward store condition. On December 9 they were weighed, divided at random into two equal groups, and housed in adjoining loose boxes. The average weight of those in Group 1 (to be fed entirely on grass silage) was 10 cwt. 0 qr. 8 lb., and in Group 2 (to be fed on grass silage supplemented with a small amount of crushed oats) 10 cwt. 0 qr. 4 lb.

During a preliminary period extending to January 3, 1949, both groups received only molassed grass silage. The bullocks took more readily to the silage than was anticipated, and in the first eleven days the daily quantity was stepped up from about 45 lb. per head to 112 lb. Although they were bedded with oat straw, the bullocks did not seem inclined to eat it, even from the very beginning. Water was laid on to each pen but was not really necessary as the bullocks seldom drank any. The silage had an obvious laxative effect, but apart from making all the bullocks scour, in rather the same way as flush grass in spring, it did not seem to upset them in any way. During the preliminary period, which was longer than was at first intended, the amount of silage consumed by the ten bullocks was 237 cwt. 2 qr. 7 lb.

The actual experimental period began on January 3, when the first fortnightly weighing of the bullocks was made. From this date Group 1 was fed to capacity on silage only, consuming approximately 126 lb. per head daily. Group 2 received a daily allowance of 4 lb. crushed oats per head in addition to a little over 100 lb. silage. The experimental period lasted ten weeks. Molassed silage was fed to both groups for the first seven weeks (when the first silo was empty), and untreated silage from the second silo for the remaining three weeks. A slight temporary reduction in silage consumption was noted for a few days after changing to the untreated silage. However, the bullocks soon recovered their appetite and seemed to find this silage equally palatable once they became accustomed to what appeared to be slight differences in flavour and odour.

Twenty-one representative samples of the silage fed to the bullocks were taken from various points throughout the silos and analyzed by the Chemical Research Division of the Ministry of Agriculture for Northern Ireland, with the following average results :

Type of Silage	Starch Equivalent(1)	Crude Digestible Protein(2)	Dry Matter	*p*H
	per cent	*per cent*	*per cent*	
Molassed	12.0	1.87	20.9	3.96
Untreated	11.8	1.81	20.5	3.88

(1) Calculated from average starch equivalent value of 57.5 for the dry matter of grass silages.*
(2) Calculated from regression equation for grass silages.*

Both silages were described as : "acid to slightly fruity, of excellent quality as judged by the *p*H values". The average protein content (on dry matter basis) was 13.87 per cent.

There seems little doubt that good silage with comparatively little loss can be made in a trench silo, as the following figures show for the molassed silage taken from the silo which was completely emptied :

Weight of grass put in	51 tons 7 cwt.
Weight of good, edible silage taken out	46 ,, 1 ,,

* WATSON, S. J. *The Science and Practice of Conservation* (1939).

Table 1
Food Consumption

	Date of Weighing	Total Weight of Pen	During previous Two Weeks				Average Consumption of S.E. per lb. Live-weight Increase
			Silage consumed	Average consumption of silage per head per day	Oats consumed	Estimated S.E. intake	
	1949	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Group 1 (Silage only)	January 3	5,866	—	—	—	—	
	" 17	6,279	8,484	121.5	—	1,018.1	
	" 31	6,482	8,925	127.5	—	1,071.0	
	February 14	6,650	8,862	126.6	—	1,063.4	5.44
	" 28	6,825	8,715	124.5	—	1,037.2	
	March 14	6,832	9,065	129.5	—	1,069.7	
	Totals for whole period	—	44,051	Average 125.9	—	5,259.4	
Group 2 (Silage and oats)	January 3	5,845	—	—	—	—	
	" 17	6,125	6,811	97.3	280	985.3	
	" 31	6,321	7,028	100.4	280	1,011.4	
	February 14	6,482	7,854	112.2	280	1,110.5	6.38
	" 28	6,664	7,805	111.5	280	1,096.9	
	March 14	6,678	7,980	114.0	280	1,109.6	
	Totals for whole period	—	37,478	Average 107.1	1,400	5,313.7	

Table 2
Liveweight Gains

	Date of Weighing	Average Weight per Bullock	Period since Previous Weighing	Average gain per head per day	
				Since previous weighing	During experimental period
	1948–49	*cwt. qr. lb.*	*days*	*lb.*	*lb.*
Group 1 (Silage only)	Preliminary period — December 9	10 0 8	—	—	—
	Preliminary period — January 3	10 1 25	25	1.8	—
	Experimental period — January 17	11 0 24	14	5.9	
	Experimental period — " 31	11 2 8	14	2.9	
	Experimental period — February 14	11 3 14	14	2.4	2.8
	Experimental period — " 28	12 0 21	14	2.5	
	Experimental period — March 14	12 0 22	14	0.1	
Group 2 (Silage and oats)	Preliminary period — December 9	10 0 4	—	—	—
	Preliminary period — January 3	10 1 21	25	1.8	—
	Experimental period — January 17	10 3 21	14	4.0	
	Experimental period — " 31	11 1 4	14	2.8	
	Experimental period — February 14	11 2 8	14	2.3	2.4
	Experimental period — " 28	11 3 17	14	2.6	
	Experimental period — March 14	11 3 20	14	0.2	

This silo was sealed and weighted with soil to an average depth of 6 inches. The weight of actual waste material was approximately 1 ton. This occurred mostly at the extreme ends of the silo, where it was impossible for the tractor wheels to consolidate the material close to the walls.

Table 1 shows the quantities of food consumed by the bullocks during the experimental period, together with the estimated intake of starch equivalent. Table 2 gives the liveweight gains.

In the estimations in Table 1 the S.E. of oats was assumed to be 60. The theoretical requirement of S.E. per lb. liveweight increase by a bullock weighing 11 cwt. and gaining 3 lb. per day is 5.47 lb. Hence the average consumption of S.E. per lb. liveweight increase by Group 1 (5.44 lb.) is just what would be expected. On the other hand, the consumption of Group 2 (6.38 lb.) was higher than anticipated, especially when it is also considered that the average daily liveweight gain of these bullocks over the whole period (Table 2) was considerably less than in Group 1.

From these results it would appear that in this particular experiment the feeding of oats in addition to a large quantity of silage was unnecessary and, in fact, a waste of starch equivalent. The two groups of animals are so small that it would be unwise to draw too definite a conclusion, but the figures do show that very satisfactory results can be obtained on a diet of silage alone.

Differences in the contents of the digestive tract at successive weighings are bound to influence individual gains to some extent, even though the weighings were as far as possible carried out at the same time of day on each occasion. Thus the high rate of gain in weight during the two weeks ending January 7 must to some extent be accounted for in this way. However, the almost entire lack of any gain during the last two-week period ended March 14 cannot altogether be explained in this way. It would seem that the bullocks, which were all very even as regards size and condition, were really "finished" at the end of February, and thereafter were doing little more than maintaining weight. Indeed the final stages of the trial were actually wasteful of food. This was borne out by the results obtained when the animals were slaughtered, and by the butchers' opinions of the carcasses.

The bullocks were disposed of through the normal grading channels. They were all fasted for twenty-four hours and weighed immediately before slaughter, after which the carcass weights were obtained. Particulars of the grading and killing-out percentages were as follows:

Group	Number of Bullocks in each Grade			Average Killing-out Percentage
	A+	Special	Super-Special	
1	–	3	2	60.0
2	1	1	3	60.4

Financial Aspect When the carcasses were hanging in the abattoir it was the opinion of two prominent butchers that they were of excellent quality with no discoloration in the fat. There was no noticeable difference in carcass quality or in type of fat between the two groups.

Reports received from the butchers to whom the carcasses were allocated confirmed the opinions given at the abattoir. The quality and flavour of the meat were excellent, the only criticism being that the proportion of fat was rather high; in present circumstances this made it more difficult for the butchers to dispose of the carcasses to the best advantage in their allocation of rations.

It is important that the financial aspect of a trial such as this should be considered, and the costs and returns are given below. No credit has been allowed for the manure, 38 tons of which were weighed out of the loose boxes, and no charge has been made for straw used as litter or for the labour of carting away the manure. The results of this experiment, whilst in no way conclusive, by reason of the small number of cattle used, do indicate the possibilities of fattening cattle economically in winter where silage is available for the purpose.

	£	s.	d.	£	s.	d.
Selling price (10 bullocks)	585	13	0			
Purchase price ,,	462	10	0			
Gross margin				123	3	0
DIRECT COSTS						
Labour	9	0	0			
Silage (48 tons @ 25s. per ton)	60	0	0			
Oats (12¼ cwt. @ 20s. per cwt.)	12	10	0	81	10	0
Surplus over direct costs				41	13	0

The returns obtained from the bullocks would have shown a higher margin had they been disposed of earlier, and it is a pointer as to what might be done with cattle in less forward condition at the commencement of feeding. It does not appear to be necessary to supplement grass silage with oats when large quantities of palatable silage are fed. Indeed, in this particular experiment it was uneconomic to do so. On the other hand, there may not be sufficient silage available on many farms to form a complete fattening ration, and a reasonable allowance of home-grown grains would probably be justified, provided silage comprises the major portion of the ration.

It is, of course, the aim of most farmers to produce high protein silage for milk production, but in practice a lot of low-to-medium protein silage would often be made and could be used economically for feeding to young stock and fattening cattle. Moreover, with higher costs of purchased foods, the use of silage, whether from special crop mixtures or from grass, has assumed increased importance, and there is little doubt that in many districts the output from our grasslands for direct consumption and for conservation could be greatly increased.

YARDED BEEF PRODUCTION

J. A. STODART
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MY farm is run on a seven-course cropping system, with about 60 acres of each crop, including only one year's grass for hay. Cropping with the sole intention of growing enough of each commodity to suit the cattle needs between 25 and 30 acres of roots : we use about 12 acres of purple-top swedes between October and the New Year, another 12 acres of long-keeping green-tops from the New Year until mid-April, and 6 acres of mangolds from then onwards. About 30 acres of oats are required to give

the necessary straw for feeding in the early stages of fattening and 20 acres of hay for the finishing process. It is quite impossible to assess with any accuracy the amount of barley straw actually needed for bedding, as we use so much straw off the potato pits for this job, thus getting a double use out of it. All this will do 90 beasts, which in turn will make just about 10 tons of dung each—enough to put 15 tons an acre on 60 acres of land for potatoes.

As a result of this system of feeding and management, we have been able to average a grading record of over 90 per cent of the beasts in the Super-Special grade. The balance consists of animals that are either too heavy to make the very top grade or have just not done well—and it is inevitable that out of a hundred beasts you will get one or two bad doers. Even this grading record does not, alas, make cattle feeding a very profitable concern. I doubt very much if any profit at all can be made at today's costs unless a feeder can get *at least* a £45 margin on each beast. Naturally it depends on the value placed on the dung that the cattle leave behind them; if you care to inflate the value of that, you coax yourself into thinking your cattle have done very well by you. Of course, there must be a limit to what dung is worth; but it is generally agreed in the arable districts of Scotland that if you can turn over your cattle so that they cover your costs, and do no more than give you the dung for the cost of handling it, you are doing as well as you have any right to expect. That really sums up our attitude to dung and the consequent importance which we attach to the production of really good Scotch beef.

Those farmers from other parts of Scotland, and perhaps particularly those south of the Border, whom we are always delighted to welcome to East Lothian, will agree with me when I say that the potato crop is the backbone of this great arable farming county, and that the dung-midden is the nerve centre of it all. At a recent debate staged by the local agricultural discussion society, two well-known beef producers (one of them just home from a tour of the Argentine) joined battle with two eminent protagonists of the new cult of keeping dairy cows in yards, instead of fattening beasts for beef. Significantly enough, a large audience voted dead level on this issue, and it was left to the chairman to give his casting vote. This he did in favour of beef.

It is no part of my task to enter the lists on one side or the other. I have a profound respect for the dairyman, who puts in his seven-day week, often, I fear, unappreciated by the townsman, who takes it for granted that somebody will put his milk on the doorstep on Sunday morning while he himself enjoys a long lie. All the same, I will say that I would much rather have an extra sixpennyworth of good English or Scotch (no, Scotch or English!) beef every week than another pint of milk.

Experience with Open Yards In the fifteen years during which I have been farming this 428-acre arable farm (I took it over when I was 17) I have definitely come to the conclusion that, to keep up the fertility of a farm, compost and artificials are inadequate—I take my stand firmly by a lot of dung and some artificials as well. The farm has been worked pretty hard since 1939: there have never been less than 413 acres under the plough, a seven-course rotation with one year's grass providing the hay crop. That it has stood up to it and is still producing 7-quarter (56 bushel) crops of wheat and barley, 10-quarter (80 bushel) crops of oats, and 9½ tons per acre of King Edward potatoes, says quite a lot for it.

I feed between 80 and 100 bullocks in the yards every winter, each yard holding a dozen beasts comfortably. Before the war, of course, when in our ignorance farms of this kind got through scores of tons of oilcake every year, we managed to turn out two relays of cattle. Those put in in October were marketed in January to make room for another lot. Today that is impossible, and so we make no effort to hurry the beasts, as we want just as much straw trodden as we can get. Having virtually no grass, I buy all the cattle during October and November, and grade them throughout April, May and June.

As we have a lot of straw to tread—not only from the machine at threshing time, but off the potato clamps throughout the winter—I have found it most productive of muck to buy a strong store, weighing around 10½ cwt., which will ultimately grade at 12½–13 cwt. This year I have just about half-and-half of home-breds and Irish : the former (black Angus crosses, cross Shorthorn-Highlanders and blue-greys grouped accordingly) came in from grass in better condition than I think I have ever seen them. The Irish bullocks, much more gaunt of frame and lacking all that character which well-bred home cattle possess, were much cheaper to buy and will, I am fairly confident, go to the graders ½ cwt. heavier than the home-breds.

On the other hand, for giving that general feeling of satisfaction at owning good quality stock—and the farmer who does not know and value that feeling is a poor fellow—the home-breds score over the Irish. In my county the Shorthorn-Highland cross bullock has made a minor invasion during the last three or four years ; so well have these cattle done for those who have fattened them that the bidding for them each October has become increasingly keener. Certainly they were the dearest cattle I bought last autumn.

I am a great believer in the open yard with a good shelter for the beasts to lie under if they want to. I well recollect an authority (at least, he had written a book!) assuring me that cattle fattened far quicker if they were exposed in an open yard, with no shelter overhead from the full rigours of a northern winter. Frankly I can't credit it. Nor am I keen on the roofed-in yard, although I do admit that the value of the dung, undiluted by rain, is probably higher. Against that, I submit that beasts in a covered yard get no benefit out of the lengthening days during spring when, in the open, the very considerable benefit of the sunshine can be derived for nothing. I am a disciple of the middle way ; an open yard with a big enough shelter attached to house all the beasts at night seems to me to be the soundest course.

Feeding Hitherto, East Lothian has been a great turnip countryside. Certainly the most noticeable aspect I find about East Anglia, or indeed about English farming generally, is the absence of roots. It has been the general habit to feed about 80 lb. of swede turnips to each bullock every day—a diet which has been spurned by the scientists on the grounds that the average swede contains about 90 per cent of water. The answer is, of course, that it must be first-class water, because I have tried feeding beasts on a balanced ration in which there were only 40 lb. of swedes, and I can vouch for the fact that the results were not nearly so good. Shortage of labour has compelled many farmers to go in for feeding turnips whole, and they tend to claim that the beasts do just as well. Personally, I cannot think that there is much difference between the effect of a whole turnip on a bullock and a thoroughly unattractively served plate of meat on me. Anyway, we continue to cut the turnips here, and the arrival of electric power a year ago has made the job fairly easy.

There is, however, little doubt that the days of turnip-growing are numbered; labour difficulties for singling and topping, and the lack of a machine for the job, are reducing the root acreage in East Lothian very quickly. Silage is taking its place, and a lot of beans and oats have been sown this spring. Kale, too, is attracting a fair amount of attention; those who tried their hand at kale silage last year are fairly pleased with the result, and there will probably be more going in for it this autumn. Tests are now being made under the direction of the local agricultural college with a view to determining whether kale silage is as good for beef production as it is known to be for milk.

The cattle here get turnips and oat straw from October until the beginning of February. The oat crop is, of course, Scotland's main cereal, as so many of our administrators tend to forget. Not only do we like our porridge, but we take good care to cut the crop before it is dead ripe, and preferably when there is plenty of sap in the straw. Oat straw cut on the green side has every bit as good feeding value as middling hay. From February onwards, hay takes the place of straw, each beast getting about 14 lb. a day. At the same time we add a ration of any available feedingstuffs. There is always a good supply of light oats and barley to put through the bruiser, and there has always been a modest helping of protein from the local Committee. Until this year we got a good supply of beet pulp, which was immensely useful. Once direction of cropping ceases, however, not even the usefulness of beet tops and pulp will induce me to grow sugar beet on a farm which is manifestly unsuitable for it—a fact which the seven-year average of only 8 tons an acre fully bears out. However, in spite of having no pulp this year, we have not done too badly, as there seem to have been a few more coupons available.

SIR THOMAS BAXTER

A career of outstanding service to agriculture ends on June 10, when Sir Thomas Baxter, now 71 years of age, relinquishes the Chairmanship of the Milk Marketing Board after sixteen years' indefatigable service in the cause of organized milk marketing. Sir Thomas became the Board's first chairman with its inception in 1933, and now, looking back on the years between, Sir Thomas may justifiably feel proud of his considerable contribution to the extensive development of the services organized by the Board today throughout England and Wales.

CLAY MARLING: SOME HISTORICAL NOTES

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This is the first of two articles on marling. The second article will appear in next month's issue and will deal with experiments recently carried out in the East Riding of Yorkshire.

IN the early days of British agriculture, dung, marl, burnt turf, burnt lime, and (later) bones were the chief soil improvers; of these, marl was one of the commonest. By virtue of its clay content, its main use was to stiffen sandy soils, to prevent "blowing" and to bind peaty soils, though various sorts of marl had different uses, as will be seen later.

In about the year 1516, George Owen(1) writes in his *History of Pembrokeshire*: "The next chiefest kind of mending of the land is the claye marle . . . and is of nature fat, tough and clammy. The common people are of opinion that this marle is the fatness of the earthe, gathered together at Noah's flood; which is verie like to be true . . . There is an ancient memorial, by continuance of report, that the use of marle in Kemmes was first found out by one Cole, a Frenchman, who was said to have come into this countrey with Martin de la Tours, the conqueror of Kemmes."*

In Volume I of *British Husbandry*, published in 1834, we read: "There are noted leases on record granted in the reigns of Edward I and II which compel the tenants to make use of it (marl); the Charta Forestae passed in 1225 mentions the right of sinking marl pits; and Daines Barrington gives a quotation from Pliny in which he mentions a substance used in Britain and France as a manure called marga, which he says is a mistake for marla. And in the Statutum Wallice 12 Ed. I, the Sherriff and Coroner are directed to enquire as to the marl pits which are in public roads, showing its then common use."

Marls Used "The term marl is employed in Cheshire," says Holland(2) in 1808, "in a most comprehensive sense including a variety of substances . . . the most common varieties are distinguished by the appellations of clay marl, slate marl and stone marl; the first . . . is perhaps the most beneficial." Among early writings the term indeed covered a diversity of substances, even to sand marl for lightening heavy soils, and in some cases marls and clay had chapters to themselves, and although some importance was attached to the lime content, the clay content of both marl and clay came to be recognized as their chief virtue. Perhaps the writer(3) of the following foresaw the existence of Provincial Advisory Chemists and their methods of mechanical soil analysis when he wrote:

March, 1795—I sent four fragments of the marl from the same pit . . . to Mr. Renwick, Chymist, in Liverpool, to be analysed.

	1	2	3	4
Flinty sand, grains	40½	40½	34	32 7/16
Clay and silicaceous earth, grains ..	39½	39	44	47 9/16
Calx, grains	19½	20½	22	20
Lost grains	½	—	—	—

These claying or marling materials in fact embraced the red Keuper marls used in Staffordshire, Cheshire and East Yorkshire, the marls of limestone and chalk origin used in eastern England, Gault clay used in the eastern counties, brick earths in the East Midlands and Kent, and a wide variety of other clays found elsewhere.

* In the twelfth century.

Methods of Marling Most marling was done by hand, and in 1795 John Holt[3] of Walton, near Liverpool, writes: "Getting and filling marl is a very laborious work . . . and can only be effected by young men in their prime, cheared by the company of their fellow labourers and frequent refreshments." A further reference to the thirstiness of the work is made in some Staffordshire figures[4] published in 1796, in which, of a total cost of £3 15s. per acre, carriage amounted to £2 10s. per acre, while labour, spreading and beer accounted for the rest.

Where the clay closely underlay the top soil more or less evenly, as in the fen country, the practice was usually to dig trenches 3–4 feet wide and 12–20 feet long, the top soil being thrown to the ends or to one side, and the clay being thrown to the sides. The lines of trenches, about 11 yards apart, were then backfilled and the clay scattered over the land. In Lancashire, Cheshire, Hampshire, East Yorkshire, and elsewhere, however, the marl was dug from pits, filled into horse-drawn carts, and shot out into regularly spaced heaps which were later spread by hand, while in 1841, William Linton[5] of Sherriff Hutton, near York, reduced his costs from £5 9s. 3d. to £5 2s. 3d. per acre by constructing a horse-driven windlass to draw the carts out of the pits. He also advises siting the pit to cut across a fence and so make a future permanent watering point for two fields. To this day, Ordnance Survey maps show that nearly every field in his neighbourhood had its own marl pit.

In 1856 Joshua Trimmer[6] compares the costs of using railway wagons as against horses and carts for transporting marl in the New Forest, while James Garnett[7] writes in 1849 of a movable light railway being used at Chat Moss in Lancashire, a system which was also used round about the same time for marling the light Bunter sands of Delamere Forest in Cheshire. Again, Henry Holland, in 1795, refers to burning the marl in kilns and clamps, bruising it into a powder and sowing by hand as a top dressing. Most farmers used their own farm labour and horses and carts, but Joshua Trimmer allows for contractor's profit, and in 1834 we hear that "where marling is regularly carried on throughout the year, it is generally managed by persons who make it their sole business".

Marling Seasons Early advice on marling is mentioned by John Davies in his South Wales Report of 1816. He quotes a translation of the sixteenth century Cattw Cymraeg's *Advice from a Father to a Son*: "Dig thy marl when thou hast completed thy spring ploughing; expose it to heat; and when rain comes stir the heaps, turning the roasted marl inwards, and the raw marl outwards; and this turning will cause it to crumble and effloresce, and collect fatness; and when winter and frost arrive, stir it again, that the weather may pulverise it; and when spreadable, lay it upon thy land, and plough it in."

Again quoting George Owen in 1516: "They use the marl thus: it is digged and cast out of the pitte, carried to the lande, and there cast either upon the fallow or lay ground, unplowed, and thus in the somer-tyme . . . or after harvest and at all tymes of the year fit for casting of it, if the weather be fine, where it lyeth so on the lande all the somer and winter, the rain making it to melt and run like molten ledd all over the face of the earth."

The general idea is expressed by John Holt in 1785: "The marl should partake both of one summer's sun and one winter's frost at least" and "The summer is the best season for laying marl upon the land, sometimes immediately after a crop of hay". And in 1842 Charles Burness[8] writes of marling on one of the sandy Woburn farms of the Duke of Bedford: "Put the clay on

the clover leys as early as the crop is off, and then get it broken in pieces as much as possible before it is ploughed in for wheat." The preference for marling on seeds instead of on fallows generally arose from the easier carting and the desire to avoid the loss of a root crop, though winter marling on land for roots sometimes provided work for men who would otherwise have had to go to the parish for relief.

Amounts Used and Results Obtained There is great variation in the size of dressing, though two main tendencies emerge. First, the use of comparatively small dressings of 40–60 cu. yards per acre, particularly on peat and fen soils, which would not stand excessive carting by iron-rimmed wheels, and secondly, the use of larger dressings of 120–300 cu. yards per acre, with an average of about 150 cubic yards.

Of the smaller dressings, Arthur Young's *Lincolnshire* (1808 edition) mentions: "Mr. Cracroft of West Keal has done most of the sandy lands on his farm. He lays 40 loads an acre. Before, the turnips ran to fingers and toes and were rarely worth more than 10s. to 12s. per acre, but now that distemper disappears as soon as the marl gets mixed up with the soil and the crops are worth £3 to £4 per acre. Barley used to produce about 2 qrs. an acre, now 5 or 6." The practice was similar in Hampshire, and Charles Vancouver(*) writes in 1810: "The quantity most commonly applied is about 45 tons of marl. Its . . . effect is to demonstrate the most beneficial consequence for a period of 25–30 years."

Of the larger dressings, W. Pitt says of Staffordshire, in 1796: "The quantity laid upon an acre is usually . . . about 128 cu. yards per acre," and in Cheshire (1808) Holland says: "On light or sandy soils 2 cu. roods each containing 64 solid yards, for a statute acre". In Yorkshire, Linton says 100–200 cu. yards per acre according to how light the land is, and just sufficient to grow wheat after seeds. The average was 150 cu. yards, though 120 years earlier (1721) J. Mortimer, in his *Whole Art of Husbandry*, describes the same area and says that 100 loads per acre is usual on these sandy soils. He goes on to say that the initial effect is not very great but that after the first year or so the effect lasts forty or fifty years, and that oats, barley and pease could be grown where only rye would grow before.

J. Worlidge's *Systemae Agriculturae: the Mystery of Husbandry Discovered* is graced by a delightful introduction in verse. The third edition, published in 1681, also describes the various sorts of marl and clay for different soils and makes a good point. "It is very necessary in marling lands to find out the true proportion, how much on every acre, that you add neither too much, nor too little. It's better to erre by laying on too little than too much, because you may add more at pleasure, but you cannot take away. This marle will keep the land whereon it is laid, in some places ten or fifteen and in some places thirty years, in heart . . . it also affordeth not its virtue or strength in the first year, so much as in the subsequent years." However, the size of dressings tended to fall by half, we are told in 1834, and almost the same benefit was achieved though not of so lasting a nature; thus a farmer could marl double the acreage at the same cost and reap all the probable benefit within the term of a moderate lease. There was no Agricultural Holdings Act in those days, so we are not surprised to read: "Tenants should be cautious . . . unless backed either by the security of a long lease, or by their entire confidence in their landlord."

As to the financial benefits derived from heavier crop yields there are many excellent costings, though too discursive to be quoted here. Two can, however, be summarized. Linton(*) in 1841 shows that the value of produce

over a four-course rotation on sandy land near York was £14 7s. per acre; after marling at 150 cu. yards the value of the produce was £24 16s. 6d. per acre if the marling was done on the seeds course, and £22 15s. if done on fallow. These figures are borne out by some costings made in the same year on claying done for Lord Harrowby at Digby, Lincs.(5) This, however, was trenching, and 15 bushels of bones were applied the year before. The value of the produce was raised from £12 9s. to £20 3s. 6d. per acre for the three-year period following, and the effect lasted for at least 15 years. Arthur Young notes that the rental value of other Lincolnshire land was increased from 4s. or 5s. per acre to 14s. or 20s.

Except for some extreme instances of 300-ton dressings on very poor land in Lancashire and other parts, marling generally paid for itself in bigger crop yields in the first 2–3 years, quite apart from reducing both the incidence of finger and toe and the growth of annual weeds on light and (probably) acid soils. Neither have 432 years disproved these words of George Owen: "The marle . . . causeth the grounde, be it ever so barren before, to bring forth fine grasse, full of the hearbe call trifolium, both white and redd, soe that in the somer-tyme the lande will be covered with these flowers and will yeald a most pleasant and fragrant odour proceeding from these sweete flowers". He goes on to say "Marle long sithence was much used about a hundred and sixty years past, as appeareth by land marled . . . and is found, by proofe, to continue good to bring corne and grasse for a hundred and sixty yeares together."

Cost of Marling An abundance of cheap labour was, of course, an inducement to marl, though there was some raising of eyebrows at the royalties charged. For instance, Mr. Cracroft in Lincolnshire paid 1s. a load, and we find Joshua Trimmer arguing that if the Crown would reduce its charge for New Forest marl from 6d. to 3d. per cu. yard, more would be used. Vancouver says that where marl was taken from Commons, some Lords of Manors charged 5s. per acre marled and others 2d. per four-horse tumbril. There are many excellent accounts of the cost of marling. In Cheshire 150 years ago the cost was as follows:

Stripping of 3 feet of overburden	12s. per cu. rood of 64 yards
Digging and filling marl	12s. ,, rood
Leading, up to 150 yards	20s. ,, ,, ,,
Spreading by hand	4s. ,, ,, ,,

or about £5 per statute acre (1 Cheshire acre is equivalent to 2 statute acres and 18½ perches).

In 1810(6), we have costs for hauls of up to one mile from pit to field, at 45 tons per acre only:

	£	s.	d.	£	s.	d.
2 men and 1 filler at 2s. 6d. per day each ..		7	6			
3 carts or tumbrils and 9 horses at 4s. per horse per day including wear and tear ..	1	16	0			
1 driver at 2s. per day		2	0			
Spreading and pulverising at 2s. 6d. per score loads		1	9			
Total for half an acre	2	7	3			
Total for one acre				4	14	6
Add fee to the Lord of the Manor					4	6
Add the expense of uncovering the marl ..						9
The whole cost of marling at this distance per acre				£4	19	9

Just over 100 years ago, William Linton(5) costed his marling as follows, on a slightly longer haul at 150 cu. yards per acre:

	£	s.	d.
Digging and spreading 150 yards at 4½d. per yard ..	2	16	3
Four horses four days at 2s. 6d. each per day	2	0	0
Driver four days at 2s. 6d. per day		10	0
Other expenses (wear and tear)		3	0
Total expenses for marling one acre	£5	9	3

Conclusion Thus was marling done in days gone by, when labour was cheap and plentiful at 2s. 6d. a day and less. We should conclude perhaps by posing some questions in the light of present-day circumstances. For instance:

(a) What is the present cost of marling using modern machinery, and does it pay at present crop prices?

(b) Is the use of modern movable oil-fired driers and of lime spreaders or combine drills too expensive these days?

(c) What are the best techniques for marling sands and for claying fens?

(d) It is better to apply a single large dressing, or periodically to apply smaller ones?

(e) What are the optimum dressings for different types of soil?

(f) Can the small farmer marl or must he rely upon contractors?

(g) Can the present-day public works contractors, with their modern earth-moving equipment, perform marling for farmers at an economical price?

It is hoped that the experimental marling recently completed for the Ministry in the East Riding of Yorkshire will help to answer some of these questions.

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THE NURSERIES OF TOMORROW'S FORESTS

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IN the forest nurseries of Britain another sowing season nears its end. In normal years, March and April are the chief months for sowing tree seeds: March for Douglas fir and native hardwoods, such as oak, beech and ash, and April for most others. Except in certain beechwoods there is relatively little natural regeneration of trees in Britain (rabbits are too numerous), and nearly all afforestation and reafforestation is, therefore, dependent on trees raised in nurseries. At the present time the State's

forest nursery stocks probably comprise more than 335 million seedling trees and nearly 115 million transplants, but this is no excessive number for the great task ahead, since foresters have not only to make good the losses caused by heavy fellings during two wars but also to expand and improve old woodlands which have been neglected ever since oak ceased to be the chief material used in shipbuilding.

The two first requirements of a nursery site are good, well-drained soil and a position sheltered, as far as possible, from both winds and frosts. In other respects there are many differences between nurseries; some cover less than 3 acres and are set in the middle of an old forest, while others are wide and open. Britain's largest forest nursery is near Cardiff. It covers more than 100 acres, employs a staff of over 50 (many of them girls), and normally has a stock of over 50 million young trees—seedlings and transplants.

Seed Much of the seed sown in the nurseries, e.g., most of the oak, ash and beech seed, and a fair quantity of Scots pine and larch seed, is collected in Britain. But some seed comes from Europe: even during the war a large quantity of larch seed and some beech seed was collected for us in German-occupied areas, and the Forestry Commission sent an officer out to Corsica, when the war was by no means over in that theatre, to buy the best of one year's crop of Corsican pine seed.

As Britain is now introducing large numbers of North American trees into her forests,* she naturally obtains quantities of seed from Canada and the U.S.A.—especially from the Far West. After the war she shared with France and Belgium an American gift of 12 million Douglas fir seeds, but even before the war she would buy such single "parcels" as 2,000 lb. of Sitka spruce seed (about 400 million individual seeds).

Effect of Climate Incidentally, western Britain's relatively mild, moist climate is especially congenial to certain of the largest and most valuable species of timber trees growing on America's Pacific coast. Such trees as Douglas fir and Sitka spruce make much better growth in Britain than anywhere on the mainland of Europe. It may be added that, in favourable sites, Britain has also surpassed Continental records of timber yields in certain European species, such as the Scots and Corsican pines. Indeed, with British forests care is necessary lest, by reason of too rapid growth, inferior timber is produced.

Because of the climatic differences between the mainland and this island, much European experience is of limited value in Britain, and, with the revival of British forestry, foresters have had to begin with quite elementary experiments. The point may aptly be illustrated by reference to tree seeds. Foresters found that Sitka spruce grown from seed collected in the Queen Charlotte Islands, off the coast of British Columbia, is less susceptible to certain kinds of frost damage than Sitka spruce grown from Californian seed. Again, Douglas fir seed from some elevations gives better results than seed from other elevations.

Research Although Britain may often be unable to benefit directly from European experience, her foresters do derive from the international exchange of seeds the direct benefit of certain errors—errors which emphasize the importance of selecting forest tree seed with the greatest care. There is a classic Swedish example: pine seed was imported from Germany, but the dealers in Darmstadt had obtained their seed from

* Ward, J. D. U. Britain's North American Trees. *Agriculture* (1948), **55**, 212.

Belgian, French and Hungarian forests, as well as from German trees. The trees raised in Sweden from this heterogeneous seed grew rapidly at first, to the joy and pride of the foresters, but disappointment followed when many of the trees proved to be of bad types, with crooked stems, thin crowns, heavy branches, and other serious faults.

Continental foresters (especially in Austria and Switzerland) have since proved that some good and bad qualities in certain species are hereditary, and in these times both Continental and British foresters are cautious about the provenance of their tree seeds. There is even now in progress a large-scale international experiment (in which British forest nurseries are co-operating) to test the qualities of different "races" of European larch, i.e., larch grown from seed collected at various elevations and from various countries. Moreover, much research is being carried out constantly in British forest nurseries: current research and experiments include the values of various weed-killers, the qualities of various fertilizers, techniques of sowing, cultivating, watering and sheltering, the characters of new hybrids, and the relationship between fungi and trees.

Methods of Sowing In those nurseries which are concerned less with research than with supplying the stock of trees for afforestation and reafforestation, tree seeds may be sown either broadcast or in the drills more usually favoured on the Continent. The larger seeds, such as oak (whose acorns weigh about 120 to the lb.—an interesting contrast to the Sitka spruce's 200,000 seeds to the lb.) are normally broadcast. The smaller kinds of seeds are usually covered after sowing with almost white "sharp sand," which gives better results in germination.

During their first winter, when the seedlings are between six and ten months old, most of them are transplanted to new positions; this work is done by hand, normally with the help of transplanting boards. The young trees, now advanced from "seedlings" into "transplants," remain in their new lines for one or two years. Then, during the second winter, they are transferred to their destined places in the forests, where they can grow into timber for tomorrow.

FROST DAMAGE TO FRUIT

THE PRESENT POSITION OF RESEARCH IN ENGLAND

W. S. Rogers, M.A., D.Sc.

East Malling Research Station

DAMAGE to fruit blossom by spring frosts, causing partial or complete loss of crop, is one of the most serious problems of the fruit industry. It affects not only the grower and the consumer, but also all the auxiliary trades; moreover, its effect is often felt beyond the actual year of damage, for it may set large areas of trees into biennial bearing and start a sequence of scarcity and glut which may take years to smooth out.

In England, research work is being co-ordinated by the Agricultural Research Council, at whose request this note was prepared, and, in response to a keen demand from the fruit-growing industry, it has been intensified in recent years. Before describing some of the latest lines of research, it is worth noting some progress that has already been made, for observation of new plantations suggests that several important points, now well established, are still not always fully appreciated.

Some Established Points The movement of cold air during radiation frosts (the commonest type) is now fairly well understood, thanks to the detailed researches of Cornford [1] and the keen observations and writings of Bush [2,3]. On calm, clear nights all objects, including vegetation, lose heat by radiation to the sky. The air in contact with them is chilled, becomes denser and so tends to move downhill, forming the so-called katabatic wind. This cold air accumulates in hollows ("frost pockets") and also gradually builds up on flat areas from which there is little or no exit to lower levels ("frost plains"). The intending planter should, therefore, select sites where the risk of damage from radiation frosts is reduced to a minimum, i.e., on hillsides from which the cold air can readily drain away to ample "receiving areas" below, with relatively small higher "donor areas" above. These sites will not afford protection from "wind frosts," but luckily these occur less frequently than radiation frosts. (See photographs reproduced on page iv of art inset).

Even the grower whose established trees are in a "receiving area" can do something to lessen his risks. The conversion of trees to late-flowering or relatively frost-resistant varieties by frameworking or top-grafting methods is now a fairly simple procedure. Examples of late-flowering apple varieties are: Edward VII, Crawley Beauty, and Royal Jubilee. Worcester Pearmain and Ellison's Orange are fairly resistant; and Conference pear will, in fact, often set seedless fruits, even when the flowers are to some extent damaged by frost.

The effect of ground cover also is now known. Grass, especially long grass, or any insulating layer such as straw, causes the air above it to cool more than air above bare soil. Cornford found the minimum temperature at 3 feet over a grass meadow was about 3°F. (and in one case 6°F.) colder than that over bare soil or within woodland. Later work at East Malling suggests that the differences between orchards in grass and in cultivation are less. Measurements in comparable orchards throughout three blossom seasons have shown that on the twenty-eight nights when at least one thermometer registered 32°F. or below, the mean difference between grass and cultivated areas was 0.5°F. at 3 feet and 0.6°F. at 5 feet 6 inches. The greatest difference recorded was only 2°F. Even so, it is clearly desirable to keep this risk to a minimum during blossom time by removing weeds and keeping grass short. Similarly, the strawing of strawberries should be delayed until the risk of frosts has passed.

The use of a pruning method, such as "renewal" pruning, which produces many fruit buds on young wood as well as on older spurs, has also been shown to spread the blossom season and so give a greater chance of escaping frost damage [4].

A new Branch of the Meteorological Office (M.O. 19) is now helping to deal with meteorological problems relating to agriculture, and one of its activities is the summarizing of frost records to show the risk of frost incidence in various areas. The broadcast frost warnings, issued by the Meteorological Office, now help growers to prepare any necessary palliative measures and give the amateur a chance to put protective coverings over tender plants.

Orchard heating with small oil burners has been found effective in certain limited areas, but, since it is laborious and costly, other protective measures are now being sought. These include infra-red heaters and air circulators, as described below.

Other methods of preventing or lessening frost damage which have been tried by workers in various parts of the world include attempts to maintain bud temperatures above the danger point by spraying continuously

with water, by irrigation, by soil heating, and by smoke screens and chemical mists to reduce radiation. None of these, in the forms tried, seems to have given results good enough to justify general recommendation.

Indirect methods include the breeding of resistant and late-blossoming varieties, spraying or injecting various substances to increase resistance, prolonging dormancy, setting of fruits by hormones, and fertilizers. Work on all these subjects up to 1945 was reviewed by the Imperial (now Commonwealth) Bureau of Horticulture ([5]). Bush ([2]) also discusses many of these points in detail.

New Research Work : PALLIATIVE MEASURES By arrangement with the Director of Fuel Research (Dr. A. Parker), two members of the staff of the Fuel Research Station, Messrs. C. Baker (physicist) and C. P. Sayles (engineer), are now tackling the problem of orchard heating, wind circulation and similar measures. The resources of the Fuel Research Station have been augmented by a mobile laboratory to facilitate work in orchards where heating and air circulation are being carried out on a commercial scale.

In order to calculate the requirements to mitigate frosty conditions of differing degrees of severity, a preliminary theoretical study has been made of the heat exchanges between fruit buds and their surroundings under various conditions of radiation and wind speed.

The latest literature on heaters and air circulators has been studied, and laboratory and field tests have been carried out on various kinds of modern equipment. For example, it has been observed that the hot gases from certain orchard heaters rise out of the orchard without contributing much to the warming of the trees, and thus the effectiveness of these heaters is due to radiation. The distribution of the useful radiation output can be modified fairly simply, but it is doubtful whether the improvement would outweigh the trouble and expense of the necessary adaptors and the probable increase in the smoke output from the appliances.

Large radiation heaters distributing infra-red rays over a wide area have important advantages, and an experimental appliance has been built and tested. The fundamental difficulties inherent in heating by radiation are : (1) the trees near the heater receive more heat than is needed, while those far away get relatively little, and (2) as radiation travels in straight lines, sharp shadows are cast by obstructions, and shaded buds receive no radiation. It may be found possible, however, to evade these effects to some extent. The use of wind machines, including helicopters, has been considered. An experimental air circulator has been assembled and has provided information likely to lead to an improvement in performance of such machines.

The National Institute of Agricultural Engineering is also experimenting with air circulators and testing large horizontal fans similar to those which have shown promise in Australia. An account, by the Head of the Institute's Horticulture Department, of some of the problems involved has recently been published in the *Agricultural Engineering Record**.

BIOLOGICAL ASPECT With the willing support of Dr. R. G. Hatton, work on the reaction of fruit plants to frost has been intensified at East Malling Research Station. Two special frost research rooms have been constructed, in which accurate control of low temperatures can be maintained ; in one of them, very low temperatures, such as are experienced in severe winters, can be reached if desired. Since 1946 Dr. I.

*Winter 1948–49, 6.

Modlibowska, whose work on winter frost damage is well known, and a post-graduate worker have devoted much of their time to spring frost research, under the general supervision of the writer of this article. A further research worker and an assistant have now been appointed.

The programme includes research into the nature of frost injury and all the factors that may affect the susceptibility and resistance of fruit plants. Much of the work in 1948 was devoted to testing the new experimental chambers and finding the best methods for freezing experiments, e.g., comparing different degrees of frost and different periods of exposure. The type of material used—trees in pots, cut spurs, or single flowers—has also proved to be important, and a preliminary study has been made of variation in damage from tree to tree, spur to spur, and flower to flower within a cluster. A start has also been made with the study of various factors, including age of flower, pollination, phase of bearing, rootstock, amount of foliage, moisture conditions, etc., in relation to frost resistance.

Temperature changes within the bud have been measured by very fine wire thermo-couples inserted in the bud, with indicating apparatus so sensitive that temperature changes caused by holding one's hand a few inches away are detectable. Using this method it has been possible to follow the freezing and thawing of a bud from minute to minute and so determine the degree of undercooling before freezing and the exact moment and temperature at which freezing of the tissue takes place. At that moment the latent heat of freezing of the water in the tissues causes an appreciable increase of temperature.

An important side of the work is the assessing of the frost resistance of commercial varieties and new seedlings. An effort is being made to find correlations between frost resistance of blossoms and any character which can be found in young seedlings, with the object of enabling selection at an early stage. If such can be found, the production of more frost-resistant varieties will be increased considerably. The breeding of such varieties has been on the programme of East Malling Research Station and several other institutions for some time, and good supplies of material for test should be forthcoming.

Detailed records are, of course, also being maintained on frost incidence in various field trials, in relation to factors such as rootstock, pruning, manuring, and ground cover.

This review does not claim to be exhaustive. Various other aspects of frost damage are being studied by workers at universities and other institutions, and by commercial firms and private growers. Work in Scotland includes studies by Dr. J. Grainger and Mr. D. Booth at Auchincruive, Ayr, during the last three years. Much research is going on abroad, especially in the U.S.A. and Australia.

The problem is certainly difficult, since basically it involves either making substantial local changes in certain natural climatic conditions, to suit existing plants, or else changing the plants to suit the climatic conditions. It would be over-optimistic to expect that any simple and complete solution will be found quickly; but careful and patient research, possibly over a long period, may be expected to yield considerable further advances.

The writer wishes to thank Dr. Modlibowska and Messrs. Baker and Sayles for help in preparing this review.

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FARMING AFFAIRS

Pit Silage, 1948-49: Mid-Wales Experience A considerable number of pit silage samples have recently been examined at the Ministry's Experimental Husbandry Farm, Trawscoed, and analytical results of the samples tested show that silage made by the pit method has turned out very well. Particular attention should be given to the following points when making pit silage:

Selection of Site. The site of a pit silo should be well drained and have a low water table.

Filling the Silo. Very efficient consolidation can be obtained by using a tractor when filling a silo of this type. Mature material that would probably badly overheat in a cylindrical silo has been well made and satisfactorily fermented in a pit silo. On the other hand, there has been a tendency to over-consolidate the more leafy material, so that the resulting silage undergoes a butyric type of fermentation. When immature leafy crops of high moisture content are ensiled, the material for the first filling should be wilted in the field for a few hours before being placed in the pit. When dealing with such crops, each 3-4 feet layer of material added to the silo should reach a temperature of about 90°F. before more material is added.

Ensiling Wet Crops. Whilst it is true that silage can be made under conditions unfavourable for haymaking, it is inadvisable to ensile material soaked with rain water. Ensiling wet leafy material will generally lead to a butyric type of fermentation, and a better product can usually be obtained with dry crops.

Sealing. In most cases pit silos are sealed with some of the excavated soil, but the efficiency of the seal varies with the type of soil. A clay soil makes a good seal, whilst a gravelly or light, stony soil makes a poor one. A seal of the latter type is useful in weighting down the surface layers to prevent their overheating, but does not prevent the entry of rain water. Under Welsh conditions of high rainfall, the large surface area of a pit silo, covered with a porous soil seal, can allow a tremendous seepage of rain into the silage. Where the soil seal is porous, galvanized iron sheets can be placed over the pit to give more effective protection against rain. The surface of the silage should slope off from the centre to the sides. The central dome can be built up from straw and rushes, and this may also prevent soil contamination of the surface layer of silage.

Periodical Inspection. After the soil has been added, settling will continue for some time, depending on the consolidation and rate of filling of the material into the silo. The seal should be inspected periodically, and

any hollows or cracks earthed up. As far as it is possible a pit silo should be filled so that the settled silage is a little higher than ground level and any rain water can run off the curved surface and away from the sides. Where the pit has walled-up earth sides and the material has settled below the level of these side walls, rain water will be trapped near the sides and will seep through into the silage, thus causing side waste. In such cases the side walls should be trimmed off level with the settled silage.

John R. Lloyd.

Whey-fed Pigs Where there are no arrangements for drying or condensing whey it is important to use the surplus whey for pig feeding if possible. This provides a supplement to normal rations and home-grown feedingstuffs; to meet cases where more meal is required to enable the whey to be consumed, County Agricultural Executive Committees have been authorized to issue the following allowances of cereal feedingstuffs *as an alternative to the normal rations*:

Until the end of June — 1 lb. for every 2 gallons of whey fed to pigs.
During July to October — ,, ,, 1½ ,, ,, ,,

Applicants will need to provide evidence or estimates of the quantity of whey to be fed to pigs in specified months. Rations issued against estimates will be adjusted later on production of documentary evidence. This supplementary cereal allowance cannot be granted when whey ceases to be available. Pig feeders should, therefore, in their own interest adjust their operations before cheese-making ceases, so that their resources will suffice to complete the fattening of the pigs or to allow of their sale to other fatteners.

Risk of Tuberculosis. The incidence of tuberculosis in pigs fed on whey is high, and in such pigs the disease is often acute. Consequently, the carcasses of pigs fed on whey are more frequently condemned on account of tuberculous infection than those of other pigs. To guard against this danger, *all whey should be boiled* before it is fed to pigs.

Nature Month by Month—May The "merry month" brings new beauty with each new day: the lovely pink-and-white candelabra of the horse chestnut, greensward spangled with the gold of buttercups, hawthorns laden with white blossom like masses of piled-up snow. In the wood the bluebells form an unbroken carpet of blue; on the crest of a rise, where the trees have been felled, they blend so nicely with the bright spring sky that one can hardly tell where bluebells end and sky begins.

Winged insect life grows more and more prolific. Bees, hoverers and others visit the wayside flowers. There are many butterflies, and the lanes are gay with dainty orange-tips. In the shadier parts of the lanes the first brood of speckled-woods is out, and on the rough waste land there are at least three kinds of skippers.

On and by the river there is much wild life. A moorhen leaves its nest in the sedges and swims jerkily into midstream. A water-vole, disturbed by the bird's passing, makes for a submerged hole in the farther bank, swimming under water very quickly in a dead straight line, its fur luminous with clinging air bubbles. A flash of turquoise blue comes downstream, alights upon a jutting alder branch and resolves itself into a kingfisher. On the farther bank a pair of swans have raised their great mound of a nest, on which the hen now sits patiently. In the tail of a pool a fat trout rises lazily to a drifting dun.

FARMING AFFAIRS

Up on the moor, curlew and redshank are brooding, and trim sandpipers are prospecting at the river's edge. The gorse is very bright with blossom now, and the ling shows rich new growth. New greys and greens of moss and lichen decorate the boulders, and the slopes of the tor, which a few months back were rust-red with dying bracken, are clothed in tender green.

The vicarage rookery is at its busiest and noisiest, for the nestling rooks are well grown and hungry, as all young birds are. In the orchard a pair of lesser-spotted woodpeckers pop in and out of the nest hole in an old pear tree. They, like the parent rooks, are full of family affairs. On a fir in the vicarage garden sits a hen cuckoo, watching patiently the movements of a pair of dunnocks in a thorn hedge below. Not for her the cares of parenthood; once her egg is "boarded out" with the unsuspecting dunnocks, she will seek another pair of victims for the greatest confidence trick in nature.

Daily the sun grows in power, awakening new life in field and hedgerow. The days draw out, and soon high summer will be here. *F.H.L.*

BOOK REVIEWS

Methods of Test for Soil Classification and Compaction. (*British Standard* 1377). BRITISH STANDARDS INSTITUTION. 7s. 6d.

Standard methods for the determination of the moisture content, liquid limit, plastic limit, plasticity index and liquidity index of soils, of the specific gravity and size distribution of soil particles, and for some soil-compaction tests are described with full working details. The methods are intended to be used in road-engineering work, but many of the details were worked out originally for agricultural soils, and some of the methods could advantageously be adopted as standards in agricultural work. *G. V. J.*

1949 Year Book of Poultry Association of Great Britain. S.P.B.A. Supplies Ltd. 3s.

The Poultry Association of Great Britain's Year Book for 1949 gives an up-to-date picture of many aspects of the poultry industry. The post-war position in England, Scotland and Wales is covered by three different authorities, Dr. R. Coles, Miss M. M. MacLeod, and Mr. H. Busher, each of them familiar with the varying conditions in the respective countries.

Fowl Pest has caused much anxiety to poultry-keepers recently, and they will be glad to have Dr. R. F. Gordon's review of the history of this disease and his summary of the present position. Mr. J. D. Blaxland, of the Ministry's Veterinary Laboratory, Weybridge, explains the limitations of post-mortem examinations, and discusses how far they can be helpful in the diagnosis of disease. Another contributor summarizes the main points in the papers read at the Eighth World's Poultry Congress.

There is a most interesting article on the fascinating subject of hormones, by Mr. J. O. Latham, the Association's Technical Adviser. His discussion of this comparatively new and highly technical matter has the great merit of being in language which can be understood readily by the layman.

Amongst other contributions there is one dealing in a general way with environment, another giving practical advice on the fold system, and a third, by J. R. Harvey and F. D. Dymond, providing a topical account of Income Tax regulations. The publication is readable and well illustrated, and it should be useful for reference. *J.W.S.*

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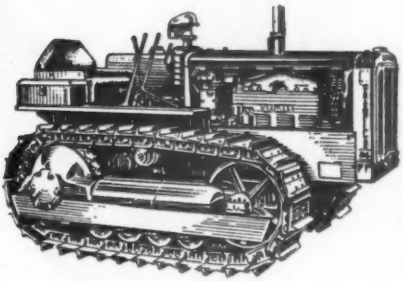

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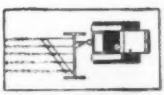

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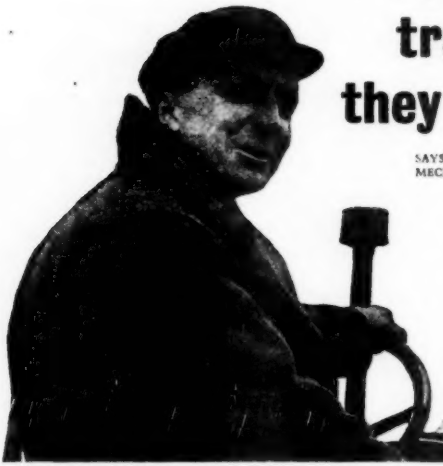

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A1/48

"Two of you lazy fellows go", it was the deep voice of Carver Doone, "and make us a light to cut their throats by".

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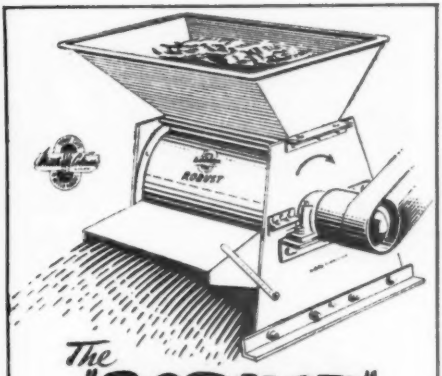

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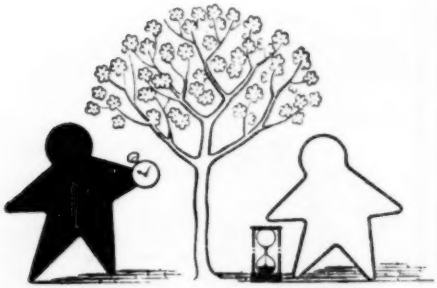

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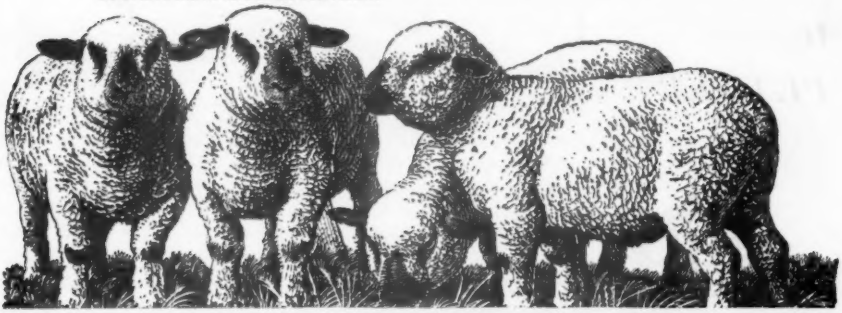

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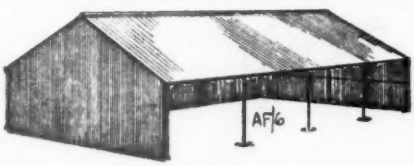

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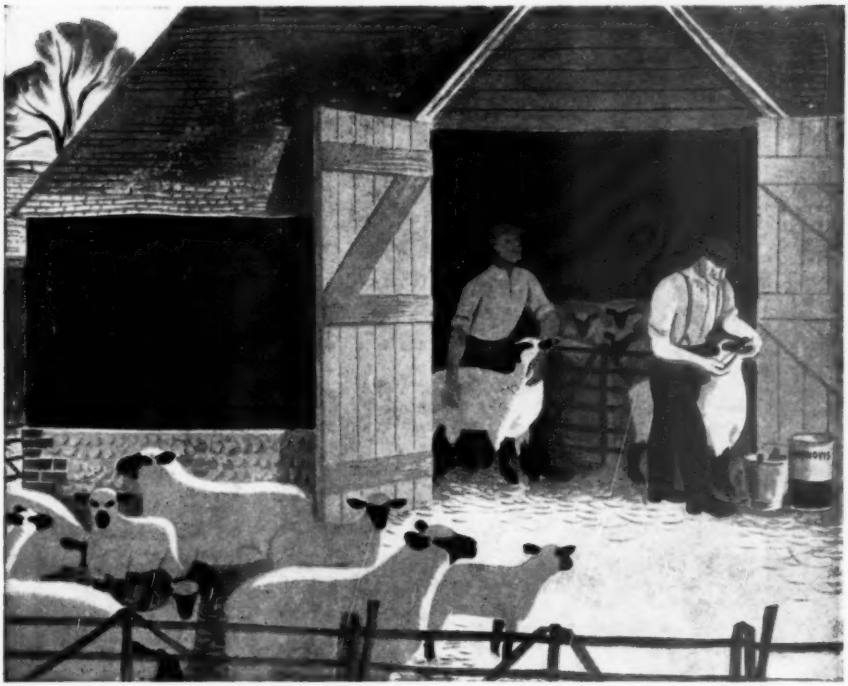

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